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WATER MANAGEMENT TO HANDLE DROUGHT: GOVERNMENT AND INTERGOVERNMENTAL RESPONSIBILITIES

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By Neil S. Grigg and Evan C. Vlachos

This is the second working paper for the project "Drought Control and Water Management in Humid Regions." The paper summarizes responses to a survey conducted in the first part of the project, and suggests roles and responsibilities for the three levels of government (federal, state, local) in order to enable the best water management for handling drought within the framework of our existing organizational and administrative arrangements. It is intended that each level of government or water management agency can derive ideas about program assessment or improvement from the paper and the workshop that it will support.

If the nation is to come to grips with its increasing drought problems, it must also improve water management. Water management is the application of structural and non-structural measures and responses to control natural and man-made water resources systems. The tasks of water management are: analysis and planning; design, synthesis and implementation of programs; and operation and maintenance of water control systems. Water control systems include supply and wastewater management systems for cities, industries and farms, as they involve water quantity and quality in rivers, reservoirs and aquifers.

Water management systems are <u>interdependent</u>; that is, each part of a chain of responsible parties has a role in determining whether water users receive the water they are entitled to in sufficient quantity and quality. This chain of responsible parties is held together by laws, regulations, policies, agreements and norms of ethical behavior. Due to our federal system of government and to the lack of integration in the water management industry, participants in water management are fragmented and often do not work well together. This failure results in unclear and unmet responsibilities for water management tasks, shortcomings that become most evident in times of drought.

Most of the publicity about drought problems is about the dilemmas of water users, principally farmers and cities. Once droughts reach the level where this type of publicity occurs, it is too late for water management actions other than those that spread the pain equitably, such as task force decisions about water saving or sharing. This paper is about the full range of water management actions to deal with drought, from the early policy and planning stages through the response phases.

<u>The changing context</u>. While drought and water shortages have been with us for a long time, the following trends have made drought water management imperative: first, drought problems are becoming a more or less regular occurrence, especially with the

increasing concern of long-term climatic change; second, the fact that new causes of drought are emerging due to man-made actions; and third, because of competing and conflicting demands between agricultural, industrial and urban water management interests.

Overall, drought problems are said to be increasing not so much because of changing climate, although that may be a problem in the future, but because of changing demands. Thus drought has two dimensions: supply side and demand side, and any long term solution or management scheme should contain a balanced approach between supply and demand measures.

Drought Definitions. Drought has many definitions. In our first working paper we explained that it is essentially a meteorological event, i.e., an extended period of dryness (Vlachos, 1988). However, due to multiple perspectives the aspect of socioeconomic demand for water must be introduced into the definition so that drought is taken in general to mean not having sufficient water to meet demands due to hydrologic shortfalls below expected levels of supply.

Some respondents to our questionnaire have stated that drought cannot be really managed. True. However, water can be managed to minimize disruption and difficulties in times of drought. This is the meaning of the term "water management to handle drought", sometimes shortened to "drought water management", or "drought management."

Drought, according to some, is neither a hazard nor a disaster, but both of these terms are used by policy researchers to describe drought. Thus we have the dilemma that drought is perceived in different ways. This difference in viewpoint is explained as follows. A hazard is defined as "...a chance happening...an accident...a possible source of danger..." A disaster is defined as "...an occurrence causing widespread destruction and distress...a grave misfortune...a total failure..." (Webster's II New Riverside University Dictionary, Houghton Mifflin Co, Boston, 1984). These definitions reveal that it is the element of expectation that determines whether a drought is a hazard or disaster or not. The water manager experiences a drought and states "we have planned statistically for this expected drought; we didn't know when it would occur, but we knew it would." The farmer or local politician states "what a disaster...we have run out of water...we were totally unprepared for this surprise drought."

This difference in perception is one of the central problems of water management for drought. If decisionmakers fail to allow water managers to properly prepare for drought, then drought is a surprise when it occurs. The water managers knew it would occur but they were powerless to prepare for it. Politicians did not want to face the prospect of preparing for it, since the chances that it would happen during their terms were small. Thus the reason that drought is a hazard and a disaster is that although

it is statistically expected, it is not politically nor economically expected. If water managers are to take measures to improve preparation for drought, these problems of expectation must be faced.

The 1986 Drought. We related in our first working paper the chronology of the 1986 Southeastern drought. In effect, the drought was judged by some to be the worst in history in that region of the US. At this point it is nor clear that the drought is over, since the region and other parts of the US are still experiencing pronounced water shortages. Furthermore, it seems that the drought is spreading over all the country with over 530 counties having been declared disaster areas by the beginning of June 1988. Indeed, parched pastures from the Northern Plains, through the Midwest to the Southeast, are the result of an unusually dry and hot Spring that follows in the Southeast three earlier dry years. Rationing on irrigators and homeowners, restricted water use hours, disconnecting of services, moratoria on growth and loud pleas for conservation are all harbingers of the long simmering competition for limited water supplies pitting urbanites against farmers and state against state. The bold title of a New York Times article of May 15, 1988 summarizes aptly the spirit of consternation and anticipation of things to come: "VAST PARCHED STRETCHES OF U.S. AWAIT HOT SUMMER." And the article concludes with the quote: "There's a double drought, a drought of reality and a drought of anticipation."

Response to the 1986 Drought. In our first working paper we presented a three part approach for drought preparation and responses. The approach provided for supply augmentation, demand reduction and impact minimization. Figure 1 summarizes once again the overall structure of approaches and responses to drought.

Figure 1 here

A survey of water management scientists and officials was conducted to determine attitudes and ideas about the 1986 Southeastern drought, with a focus on these three aspects of drought water management. The 35 respondents (to about 100 queries) included 15 from state government, 10 from federal agencies, 9 researchers and one from local government. Of these 23 were familiar with the Eastern US, including the Southeast, ten were familiar with the Midwest/Mountains region and two were familiar with the West Coast.

The respondents were asked about roles and responsibilities for different phases of drought preparation and response. They saw the main responsibility being that of the states for drought preparation and management. In the case of relief, they saw a shared federal-state responsibility and for drought description/ forecasting, they perceived a regional responsibility, probably implemented through federal programs.

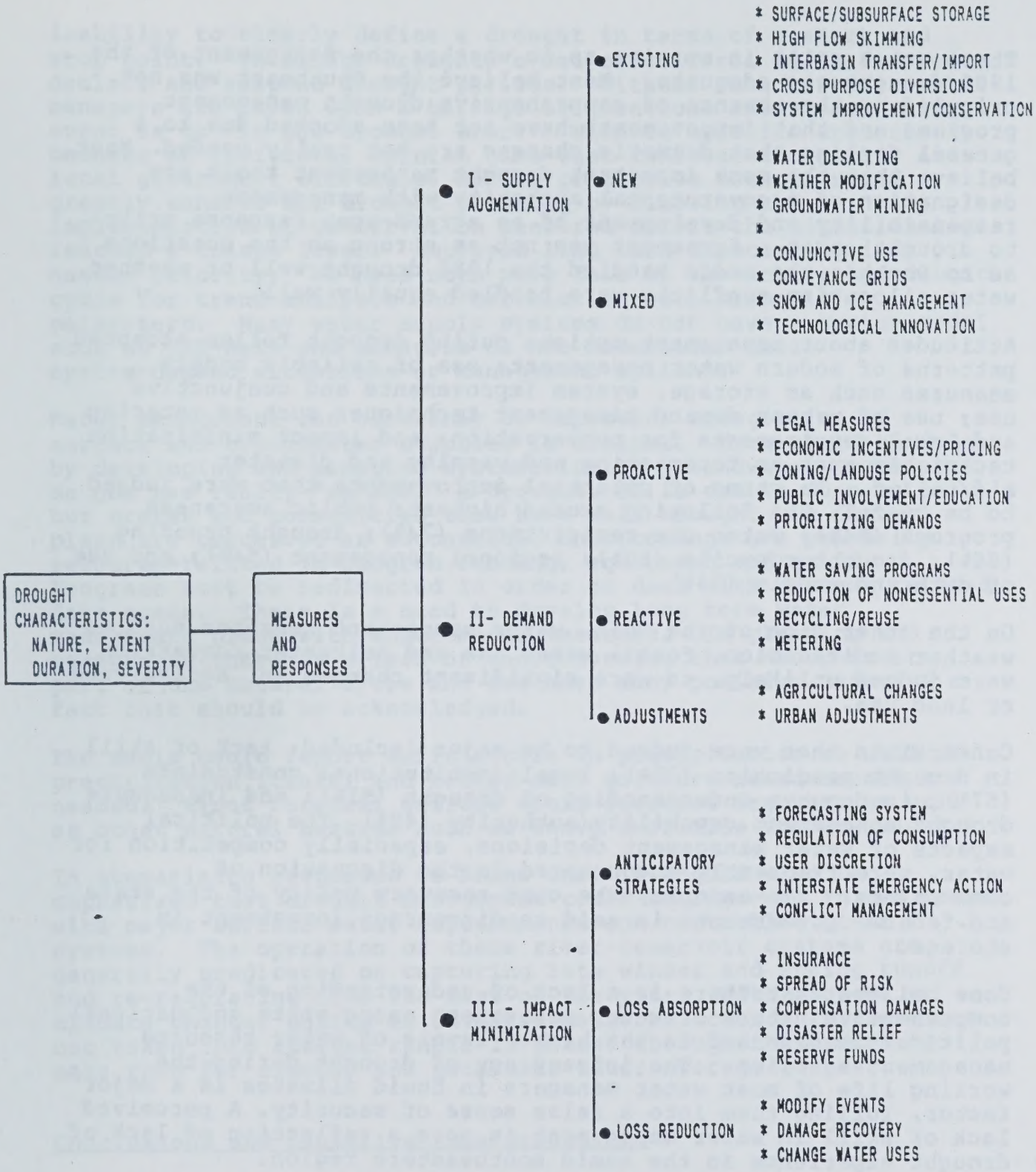

Figure 1. Management Strategies for Drought

There was a split in opinion as to whether the management of the 1986 drought was adequate. Most believe the Southeast was not crippled by the absence of comprehensive drought management programs and that improvements have not been adopted due to a general feeling that dramatic changes are not really needed. Most believe that the most important drought management tools are designation of a governmental authority with management responsibility and development of an agreed-upon response prior to drought onset. Agreement was not as strong on the questions as to whether the media handled the 1986 drought well or whether water allocation conflicts were handled equally well.

Attitudes about management options during drought follow accepted patterns of modern water management: use of reliable supply measures such as storage, system improvements and conjunctive use; use of proven demand management techniques such as metering and legal requirements for conservation; and impact minimization techniques such as forecasting and warning and disaster aid/relief. In terms of potential improvements that were judged to be useful, the following scored highest: public awareness programs (74%); water use restrictions (74%); drought proofing (66%); drought councils (60%); regional management (54%); and use of data and models (54%).

On the other side of the coin, water management measures such as weather modification, fossil water use and saltwater conversion were judged unlikely, as were significant changes in agriculture or land use.

Constraints that were judged to be major included: lack of skill in drought prediction (77%); legal/institutional constraints (57%); inadequate understanding of drought (51%); and inadequate drought management capability/authority (49%). The political aspects of water management decisions, especially competition for water, were frequently encountered in the discussion of constraints. For example, the cost recovery policy of the state and federal governments is said to discourage investment in storage.

Some believe that there is a lack of understanding of the comprehensive nature of water management among state and national political leaders and in the higher levels of water resource management agencies. The infrequency of drought during the working life of most water managers in humid climates is a major factor, lulling them into a false sense of security. A perceived lack of skill in water management is more a reflection of lack of drought experience in the humid southeastern region.

Bringing new technologies in the form of data and models for drought management can be useful, but it needs to be better organized and supported. Coverage of NWS/USGS gages is said to be inadequate for site specific management of drought in parts of various states. Drought severity and magnitude are not known until events are over. Tied closely to this problem is the

inability to clearly define a drought in terms of a start and stop point. To manage droughts a set of criteria is needed to declare and suspend drought periods. Without such criteria water managers are faced with a barrage of questions after each rain event as to "is the drought over?" Without specific criteria it becomes an individual opinion game that confuses the public and local government officials. Better predictive methods would greatly enhance all drought planning by allowing the implementation of conservation measures before the situation has reached a crisis level. Improved long term forecasting is a needed priority. We need much more data on the entire hydrologic cycle for trend analysis and correlation with climatic parameters. Many water supply systems do not have a system model such as IWR-Main and managers do not understand their system-demand situations or management options.

Water management can certainly be improved. Integration of surface and groundwater supplies is minimal. Much could be done by developing and managing systematically groundwater supplies. No one has really "managed" a drought, if it can be done at all, but states and communities that have well thought out drought plans are perceived as successful. Shortcomings are primarily resource-related in program funding, equipment and staff. Programs must be redirected in order to deal with drought related data needs. There is a need to develop long term water management plans with enforcement measures. In planning and management there is a lack of understanding that droughts are part of the natural cycle and can have many positive aspects, a fact that should be acknowledged.

The media could report deficiencies in precipitation as well as precipitation itself, and better soil moisture measurements are needed. Flood forecast offices could forecast droughts as well as other natural hazards such as heavy snowfalls and mudslides.

In summarizing responses to Round one, it should also be emphasized that drought management could be improved in the zones with major surface water impoundments and controlled river systems. The operation of these river-reservoir systems are generally predicated on capturing late winter and spring runoff and re-regulating flow the rest of the year. With drought or climate change, shifts in rainfall patterns occur. If these are not taken into account runoff is passed through the system to make room for floods, and potential water storage is lost.

Conclusions and tentative interpretation.

Looking back at the review of literature, responses to our first survey and on-going developments, there are certain distinct overall themes that emerge. Two of them have already been introduced, while the third is new, especially as a result of the "drought of 1988." Briefly, in the form of questions:

1. How well are we using our information technology in describing parameters of impending and on-going drought?

2. How well do we coordinate intergovernmental activities in planning for and meeting the challenges of managing drought?

3. Given the centrality of agriculture in many of the discussions and measures of drought, how well are we mobilizing or using irrigated agriculture, especially in humid environments and particularly for higher value crops?

In the context of earlier remarks, we need to recognize that as a result of increasing complexification, interdependence and vulnerability, four types of interdependencies call for urgent intergovernmental integration (through coordination, cooperation and consolidation):

1. Hydrologic interdependencies in terms of both uses (rural, urban, industrial, recreational, etc) and water regime (i.e., surface and groundwater, quality and quantity).

2. Political interdependence as expressed in terms of two subdimensions (horizontal or coordination in space; and vertical, representing cooperation between levels of government units).

3. Transboundary interdependence representing both social and hydraulic transnational or trans-state interdependences.

4. Exogenous interdependencies, notably the potential dramatic impacts and consequencies of climatic shifts and hydrologic alterations.

In a simple diagrammatic form, our overall concern can be summarized in the following descriptive figure:

Thus we recognize "interdependence" as part of a diagnosis or the state of the system, and "integration" as a desired end result, action or goal attainment. Our tentative interpretations and conclusions, then, include the need for:

1. Policy analysis. The states need to assess their preparation for water management to handle drought conditions. Since most believe that the most important drought management tools are designation of a governmental authority with management responsibility and development of an agreed-upon response prior to drought onset, states can assess whether they have these capabilities. Provision for drought councils and regional solutions and for long term water management plans with enforcement measures are truly a state responsibility.

2. Education. The difference in perception of whether drought is a disaster/hazard, or an expected event to be prepared for, points out the need for education of officials and of the general public. Many water managers in humid climates have not

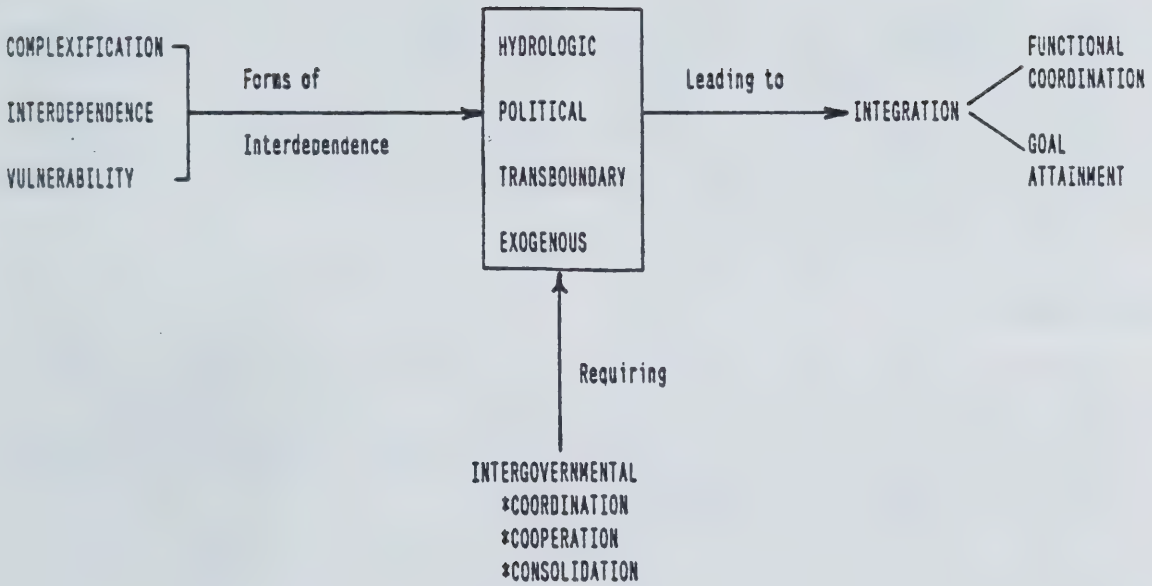

Figure 2. Characteristics and Results of Water Management Actions

experienced drought, and have a false sense of security. Political leaders and executives of water resource management agencies need to understand the complex nature of water management and the need for studies and preparation for drought. In our survey the need for public awareness programs was cited by 74% of the respondents.

3. Technologies. New information-based technologies in the form of data and models for drought management can be useful, but they need to be better organized and supported. Water management technologies such as integration of surface and groundwater supplies need special attention. Management technologies such as regional cooperation also need increased attention.

4. Data collection and prediction. Coverage of NWS/USGS gages is said to be inadequate for site specific management of drought in parts of states. Drought severity and magnitude are not known until events are over. The inability to define a drought in terms of a start and stop point hinders water managers. Better predictive methods would allow conservation measures before the situation has reached a crisis.

Afterthoughts

While the above summarize, more or less, responses to our first survey and exemplify concern with the "1986 drought" currently unfolding events and circumstances provide us with a unique challenge and opportunity. Drought management seems to be not a palliative response to a temporary crisis. Instead, climatic shifts, socio-economic changes, and national and international interdependencies call for more integrated and far-reaching policies and strategies. Some have even called the emerging drought of 1988 the "first volleys of the new water wars" (US News and World Report, May 30, 1988). As one interviewee noted there: "we rely on a `hydro-illogical' cycle. When there's plenty, there's apathy; with shortages, there's panic." (ibid, page 22.)

It is exactly this spirit of crisis management that we should avoid. How to move, instead into a risk management emphasis, anticipating, contingency oriented planning and management approach is the challenge to a highly complex, interdependent social and environmental system. Even more, our quest should be one of reasonable and pragmatic operational steps for handling more frequent and more severe droughts. Moving from reality to practice, from rhetoric to reality and from diagnosis to action are the central themes of our forthcoming meeting. While there is an air of urgency, one should not panic into spasmotic responses or untested technological approaches to managing the water resources of the nation. To that end we invite your participation, your experience and your vision.

Drought in the Southeastern United States, 1985–86

By Harold G. Golden and Harry F. Lins

INTRODUCTION

A severe meteorological, hydrologic, and agricultural drought occurred in parts of the Southeastern United States during 1986. Rainfall was below normal throughout much of the Southeast during 1985, and, except for Arkansas, Florida, and Louisiana, remained much-below normal during the winter, spring, and early summer of 1986. This persistent rainfall deficiency resulted in a major drought over a large geographical area (fig. 9) during the summer of 1986.

The word "drought" has different meanings to different people. To a farmer a drought is a deficiency of moisture that affects the crops under cultivation—even 2 weeks without rainfall can stress many crops during certain periods of the growing cycle. To a meteorologist a drought is a prolonged period of moisture deficiency—a drought lasting 1 to 3 months is considered short term, 4 to 6 months is intermediate, and more than 6 months is long term. To a water manager a drought is a deficiency in water supply because of its effects on water availability and water quality. To a hydrologist a drought is defined in terms of the effects of periods of deficient precipitation on water resources—these effects can include deficient streamflow, declining reservoir contents, reduced soil moisture, and falling ground-water levels.

In 1985, precipitation and streamflow varied greatly throughout the Southeast, and monthly streamflow averages were below normal for much of the year. In much of Alabama, Georgia, Tennessee, North Carolina, and South Carolina, precipitation ranged from 65 to 95 percent of normal and streamflow ranged from 50 to 80 percent of normal. These 1985 dry conditions were followed by very low rainfall in the winter and spring of 1986. Streamflow in many rivers was below average for the first 7 or 8 months of 1986, which resulted in extreme low flows in eastern Alabama, eastern Tennessee, Georgia, and the Carolinas during July and August 1986. As of mid-August 1986, streamflow had increased from the minimum for the year and did not recede again to that extreme low.

Ground-water levels, which usually are highest in April and May, were below normal during those months in 1986. As the rainfall deficiency persisted, ground-water levels began to recede at greater than normal rates from already lower-than-normal levels. Ground-water levels remained much-below normal during the summer growing season as the rainfall deficiency continued. However, above-normal rainfall occurred in late summer and fall and provided recharge over most of the area; as a result, the water levels in most observation wells began to rise during September, October, or early November, depending on geographic location and depth of the wells.

CLIMATOLOGICAL CONDITIONS ASSOCIATED WITH THE DROUGHT

The progressive development of drought conditions across the Southeast during the winter and spring of 1986 resulted from anomalous seasonal patterns in the general atmospheric circulation. The most notable departures from normal were a relatively weak and variable flow in the subtropical jet stream over the Southeastern United States and the absence of low-pressure troughs over the lower and middle Mississippi River valley at the 700-millibar level (about 10,000 feet). Typically, during winter and spring months a strong subtropical jet flow coupled with occasional upper-level troughs over the Mississippi valley promotes the development of large-scale cyclonic storms over and along the margins of the Gulf of Mexico. Usually several such storms will form and move north-eastward, spreading abundant precipitation across the Southeast. In 1986, however, fewer than normal storms formed in the Gulf area and those that did form generally were weak and produced insufficient rain to break the drought. To summarize, the upper-level circulation of the winter and spring period was characterized by an alternative pattern of troughs displaced either west of normal (accounting for above-normal precipitation in the Central Plains, northern Mississippi River valley, and western Great Lakes area) or east of normal (along or just offshore of the East Coast) bringing enhanced precipitation to parts of Florida and extending well offshore into the Atlantic.

Although the late spring and early summer circulation pattern was close to normal, the typical surface pattern of convective showers and thunderstorms characteristic of the region never materialized. Through June and early July an upper-level trough persisted off the east coast with an adjacent upper-level ridge over the Southeast. The dry subsiding air associated with the ridge effectively blocked the normal influx of moist air from the Gulf of Mexico, leading to record dryness across much of the area by the end of July.

During the first 2 weeks of August, low pressure aloft moved over the Southeast bringing an increase in convective activity. In fact, many parts of the region received unusually large quantities of precipitation in mid-August. Although the moisture deficits by this time were very large, this abundant moisture did alleviate the streamflow-drought severity. By late August and throughout September, the Southeast again was largely under the influence of high pressure aloft, which resulted in below-normal precipitation. However, streamflows did not recede to the extreme lows of late July and early August.

HYDROLOGIC CONDITIONS ASSOCIATED WITH THE DROUGHT

PRECIPITATION

Precipitation during 1985 ranged from 65 to 95 percent of normal in much of the Southeast excluding the States of Arkansas, Louisiana, and Florida. The below-normal rainfall in 1985 was followed by extremely low rainfall in the winter and spring of 1986. The percentage of normal precipitation at selected stations in each State for the period January to August

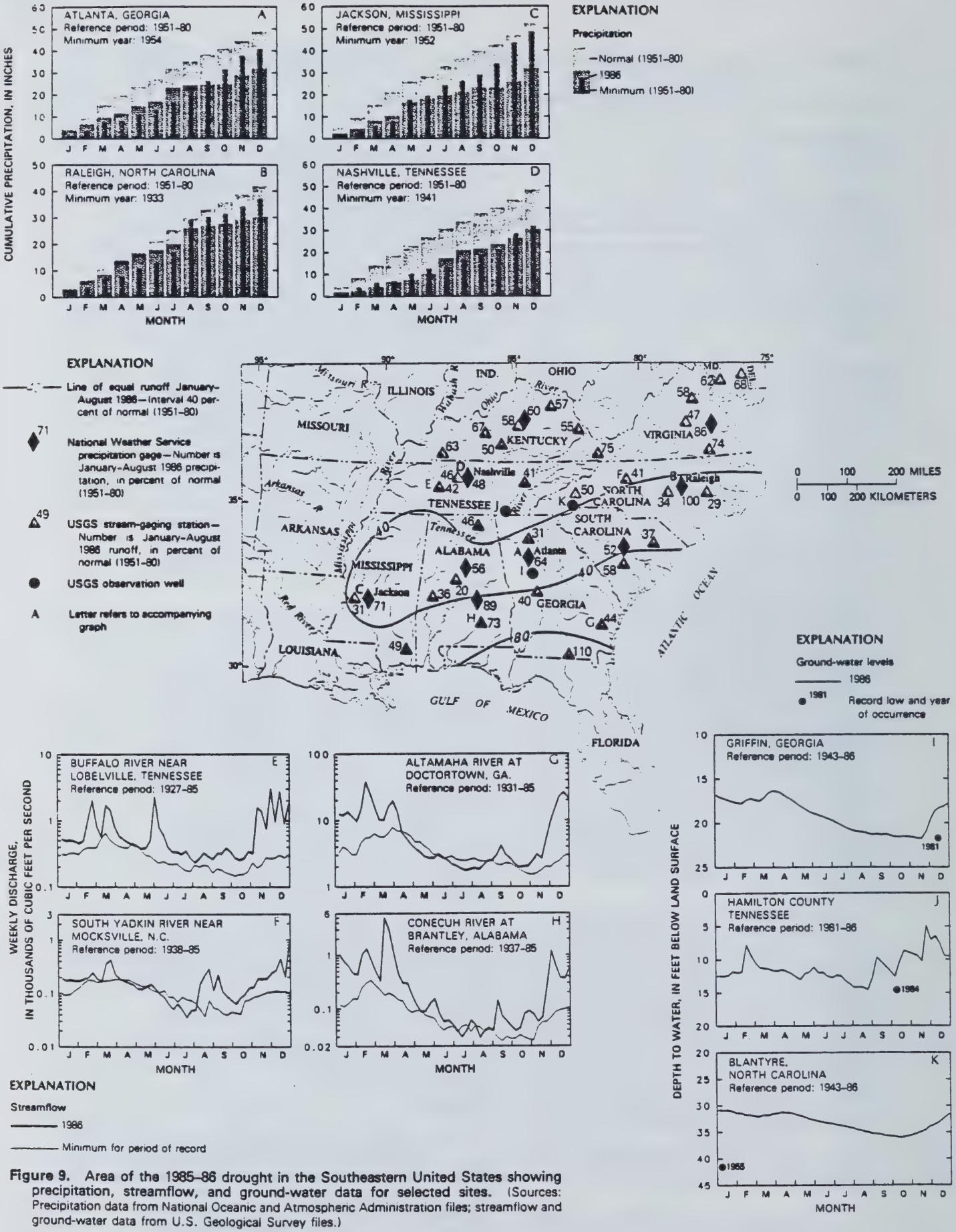

Figure 9. Area of the 1985–86 drought in the Southeastern United States showing precipitation, streamflow, and ground-water data for selected sites. (Sources: Precipitation data from National Oceanic and Atmospheric Administration files; streamflow and ground-water data from U.S. Geological Survey files.)

is shown in figure 9. Also shown are the cumulative monthly precipitation for 1986, normal precipitation for the 1951–80 reference period, and the previous minimum year of record for four locations—Atlanta, Ga., Raleigh, N.C., Nashville, Tenn., and Jackson, Miss. In Atlanta (fig. 9*A*) the cumulative precipitation in 1986 was lower than the minimum year of record (1954) for January–August and in Raleigh (fig. 9*B*) it was lower than the minimum year of record (1933) for January–June. In Nashville, Tenn. (fig. 9*C*), and Jackson, Miss. (fig. 9*D*), the cumulative precipitation was below the minimum year of record in the middle or early part of the year, respectively.

Rainfall in June and July produced runoff that alleviated the drought to some extent in Mississippi, Alabama, western Tennessee, and Kentucky. In late August, heavy rains following Hurricane Charley reduced the rainfall deficit for the year in parts of North and South Carolina and southern Georgia and locally produced flooding of small streams.

The chronology of the 1986 drought is documented by the drought-severity index maps shown in figure 10. Maps for mid-April to mid-September show the progression of the drought. In mid-April the extreme drought was limited to a small area in eastern Tennessee and the western Carolinas. By mid-July it had covered most of Georgia, the Carolinas, Virginia, Maryland, eastern Alabama, eastern Tennessee, and southeastern Kentucky. In mid-August the area of extreme drought remained about the same, but by September it had receded to eastern Alabama, eastern Tennessee, western North Carolina, and Georgia. This expansion and contraction of the drought area is consistent with the streamflow data discussed below.

Streamflow

Streamflow in much of the Southeast was only 50 to 80 percent of normal for 1985. The low flows continued into the first 8 months of 1986, when many streams had the lowest seasonal flows of record for the season. The cumulative runoff for the year through August 1986 as a percentage of normal is shown in figure 9. From Mississippi to North Carolina the yearly runoff through August was less than 40 percent of normal. In other parts of the drought area streamflows were less than 80 percent of normal except for southern Georgia, which had heavy rains in late February. After these rains little precipitation occurred in southern Georgia until August, and streamflows were low from March through July.

Weekly flows for 1986 and the minimum weekly flows for the period of record at selected streamflow-gaging stations in Tennessee, Alabama, North Carolina, and Georgia are shown in figure 9*E–H*. Each of those stations had some daily flows below the previous minimums. New minimum flows of record also occurred in late July at several other long-term gaging stations (50 years or more of record) in Georgia.

A statistic widely used by water-quality and water-use managers to estimate the reliability of a surface-water source for water supply or for use in diluting waste discharge is the 7-day 10-year low flow (lowest average flow for 7 consecutive days with a 10-year recurrence interval). The 1986 flows were below this average flow for 54 days at the Georgia station, 34 days at the North Carolina station, and 28 days at the Alabama station; no days were below that average flow at the Tennessee station. Tennessee also uses the statistic 3-day 20-year low flow, and no days were below that flow at the Tennessee station. The hydrograph trends through August show that serious flow deficiences occurred and that new record minimum flows were set by many streams in the most severely affected parts of the Southeast. The time of occurrence of these record minimum flows in July and August is rare for the Southeast, where annual minimums usually occur in September and October. Also, the occurrence of the extreme low flow during months of high-evapotranspiration loss caused the recession in flow to be more rapid than had been previously experienced in this flow range in many streams.

When comparing monthly streamflow to normal (reference period 1951–80), July was the lowest month for this drought, and at many stations in the Southeast, July streamflow also was the lowest July flow of record. Streamflow for July 1986 expressed as a percentage of normal July flow is shown in figure 11.

In northern Georgia and the eastern Carolinas, streamflows during the 1986 drought were near the lowest in this century. The minimum daily flows of several streams in these areas were lower than those in 1931, 1941, 1954, and 1981 and were near the record low flow during the 1925 drought. In the most severely affected area, the recurrence intervals of the 1986 annual minimum daily flows for many streams were between 50 and 100 years. The 1986 annual streamflows in this area were much-below normal with recurrence intervals between 50 and 100 years.

Reservoir Levels

Many reservoirs in the Tennessee River basin were below normal summer levels in 1985, and several reservoirs in east Tennessee, north Georgia, and western North Carolina were still below normal in September 1986. However, mainstem reservoir levels were maintained at near-normal elevations because of less-than-normal releases for hydropower generation.

Lake Sidney Lanier in northern Georgia is the primary water supply for Metropolitan Atlanta and also is the most popular recreation lake of all the U.S. Corps of Engineers' reservoirs nationwide. In late October, Lake Lanier was at the lowest level recorded for that time of year—16 feet below normal summer lake level. Boaters were cautioned to watch for submerged objects because of the low lake level. (See figure 12.) In late August the Corps of Engineers significantly reduced flow releases from Lake Lanier. This, coupled with runoff-producing thunderstorms in the headwaters and below-normal air temperatures that reduced evaporation losses, reduced the rate of decline in the lake level during late August; by late October the lake level had begun to rise, and at year's end it was only 11 feet below normal summer level.

Elsewhere in Georgia, low reservoir levels caused boat ramps to be out of water, exposed objects normally submerged, and rendered the lakes esthetically unpleasant. Thus, recreation and visits

decreased an estimated 25 percent at Allatoona Reservoir and 10 to 20 percent at Hartwell, Russell, and Clarks Hill Reservoirs.

The most severely affected reservoirs in Alabama were on the Coosa and the Tallapoosa Rivers. Deficient rainfall during the months of December 1985 through April 1986 resulted in below-normal reservoir levels. To conserve water, reservoir releases were reduced to minimum requirements. This practice was continued through the summer and reservoir levels in September remained below normal.

Ground Water

Ground-water levels in the areas affected by the drought generally were below average during mid-1986. In parts of the Piedmont (central Georgia and central Carolinas), water levels during the summer months were lower than during the same period of the 1981 drought. A record low water level was established at a Griffin, Ga., observation well during the fall (fig. 9*I*). In parts of southwest Georgia, larger-than-normal withdrawals for irrigation induced by the drought resulted in record low water levels. Elsewhere in southwest Georgia, below-normal precipitation reduced recharge and increased demand for irrigation to the extent that water levels in some areas reached record lows by the end of the summer.

In Tennessee, ground-water levels had been below normal since December 1985, and record low water levels were reached at two wells in middle Tennessee during April and May 1986. Water levels recovered slightly and were near normal throughout the State following rains in late May and early June; however, the rainfall was insufficient to maintain the rise in water levels and by August the water level had declined to a near record low in one well (fig. 9*J*) before levels began to rise again.

In early September, ground-water levels in unconfined aquifers in North Carolina remained well below normal in the western part of the State, were near normal in the central part, and were above normal in the eastern part. Ground-water levels began to rise in October in the western and central parts of the State (fig. 9*K*), and in January 1987 in the eastern part.

In east-central Alabama low ground-water levels were reflected in record low discharges of Coldwater Spring near Anniston in August.

EFFECTS OF THE DROUGHT

Agriculture

The 1986 drought severely affected the agricultural economy of the area. The Georgia Department of Agriculture estimated losses at $319 million. Maryland reported losses of $117 million, South Carolina $165 million, North Carolina $325 million, and Virginia $303 million. In July and August, pastures in much of the drought area were in poor condition, supplemental feeding of livestock was required in many localities, and ranchers marketed more cattle than usual. As of mid-September, many counties in each State were declared eligible for Federal drought relief: Alabama, 67; Georgia, 159; Maryland, 22; Mississippi, 39; North Carolina, 81; South Carolina, 39; Tennessee, 75; and Virginia, 83.

Irrigation water use in southwest Georgia during 1986 exceeded the withdrawals made during the 1980–81 drought. In Georgia about 65 percent of the withdrawals were from ground-water sources and the remaining withdrawals were from surface-water sources. Irrigation use in other parts of the Southeast, although not as large, followed the same pattern. In North Carolina some water shortages resulted when irrigation ponds were depleted.

Water Supply

Shortages in surface-water supply were experienced throughout many areas of the Southeast in 1986. In Georgia, water-supply shortages first occurred in a few Atlanta metropolitan systems, primarily because of high demand and small reservoir storage. As the drought continued, several systems in the southern part of the metropolitan area also had water-supply problems. Several municipalities in north and central Georgia had surface-water-supply shortages.

North and South Carolina reported water-supply problems in a number of municipalities throughout the States, and in central Kentucky, several communities that rely on surface water experienced shortages and imposed use restrictions. Fortunately, precipitation in late August and early September helped abate most surface-water-supply problems.

Shortages of ground water from rural-domestic wells were noted primarily in the northern one-third of Georgia and in southern Tennessee where several hundred wells were reported dry. Most public-water supplies in these areas rely on surface water and also experienced water shortages.

Water shortages occurred in some Alabama communities that are supplied by ground water. Coldwater Spring, one of Alabama's largest springs and the source of water for about 70,000 people in the Anniston area, reached a record low flow in August. In the Mississippi Delta, record low ground-water levels were set in August because of the drought and heavy irrigation demands.

Water Quality

Quality of the water in some major reservoirs, especially in the Tennessee River mainstem reservoirs, was seriously degraded by the drought. Water temperatures were uncharacteristically high at depths as great as 80 feet, dissolved-oxygen concentration and pH were lower than normal, and aquatic weed growth was excessive. In Kentucky Lake, fish reportedly were sluggish, about 65 percent of the catfish caught by commercial fishermen could not be sold because of their poor condition, and minor fishkills were reported. Some industries curtailed operations to reduce waste releases to the Tennessee mainstem reservoirs.

The Alabama Department of Environmental Management reported about 80 fishkills that were suspected to be related to wastewater discharges. Fishkills were reported in northwest and southwest Mississippi on the Yazoo River and Bogue Chitto, respectively. Fishkills reported in Georgia were

primarily due to low streamflow and high temperatures. Significant water-quality effects reported by North Carolina include blue-green algae blooms and fishkills in the headwaters of Falls Lake near Raleigh, and fishkills in Middle Creek near Clayton.

Chloride and sodium concentrations were a problem for Chesapeake, Va., which has a water intake on the Northwest River. Abnormally high concentrations in August 1986 were caused by low freshwater flow in the river, which reduced the normal flushing and dilution in this tidal stream. Locally heavy rains and resultant runoff in late August reduced the problem. Fortunately, there were no reports of major algae blooms such as the one on the James River that caused taste and odor problems for Richmond, Va., during the 1980–81 drought.

MANAGEMENT ACTIONS IN RESPONSE TO THE DROUGHT

To conserve water and minimize the effects of reduced precipitation and streamflow in 1986, the affected States resorted to drought emergency plans or other management actions. Actions also were taken to minimize the effects of low flows on hydropower generation. These actions are described below.

The first major restrictions on water use in the Southeast region occurred in June 1986 in the Atlanta metropolitan area when several water authorities limited or banned outdoor water use. These restrictions were imposed because heavy demands caused by the drought exceeded the storage and distribution capacities of the systems or the maximum permitted withdrawals were being approached. During July, the Georgia Environmental Protection Division (EPD) notified more than 100 communities in north Georgia to adopt water-conservation measures, and most of the communities complied. Several of these communities imposed total bans on outdoor water use, and a few localities, because of insufficient supplies, also requested reductions in industrial use. In mid-August about 330 ground-water users, mostly in southern Georgia, were notified by EPD to adopt water-conservation practices by September 5. Most users implemented these practices, but before they became completely effective, rain in October reduced their impact.

The Kentucky Cabinet for Natural Resources issued a "water shortage watch" in mid-August to warn local officials of the potential for shortages if dry conditions persisted. The watch, which advised local officials to monitor water supplies and to begin conservation measures if shortages continued, was especially important for public water-supply systems that depend on small streams.

A Drought Task Force made up of representatives from State and Federal agencies was established by the Governor of Alabama in the summer of 1986 to consider all aspects of the drought. By October 1, 1986, the Task Force actions to reduce hydropower generation had resulted in a 25-percent reduction in releases from five reservoirs in the Coosa and the Tallapoosa River basins in Alabama.

As early as 1985, the State of Virginia in response to the drought conditions established a Drought Monitoring Task Force under the auspices

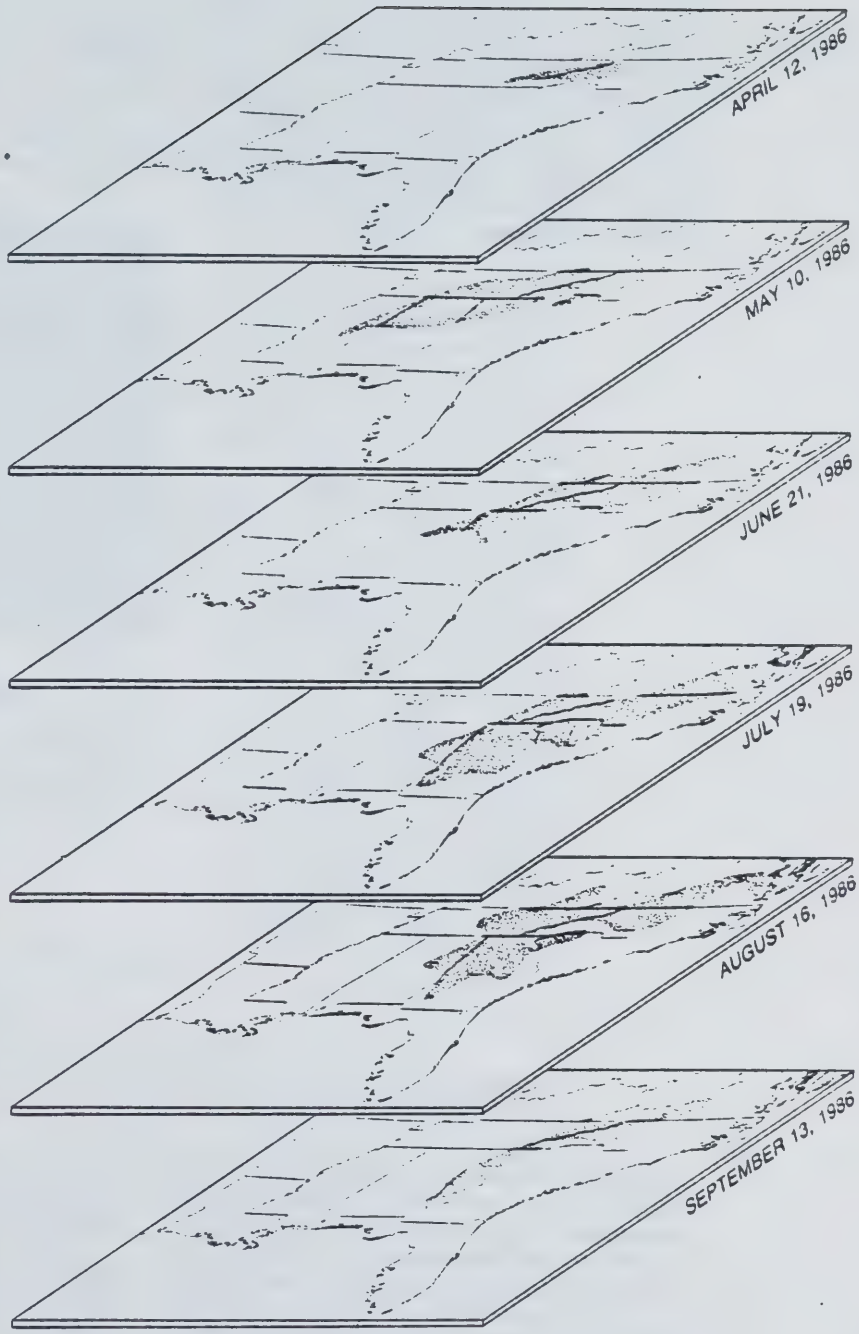

Figure 10. Area of extreme drought in the Southeastern United States, April 12, 1986, to September 13, 1986. The term "extreme drought" is derived from the long-term Palmer Drought Severity Index, which is based on precipitation, evapotranspiration, and soil moisture conditions—all of which are determinants of hydrologic drought. (Source: Data from National Oceanic and Atmospheric Administration and U.S. Department of Agriculture Joint Agricultural "Weekly Weather Crop Bulletin.")

of the Virginia Water Control Board. When drought conditions persisted into the spring of 1986, the Task Force was reactivated. It consisted of representatives from the Virginia Water Control Board, Department of Health (public water supplies), Department of Agriculture, Division of Forestry, Department of Emergency Services, State Climatologist, the National Weather Service, and the U.S. Geological Survey. The Task Force issued biweekly statements on current hydrologic and agricultural conditions as well as near- and long-term weather forecasts. In late August, the Virginia Governor's Office issued letters to all communities and large industrial water users requesting voluntary conservation of water in order to mobilize citizen participation in conservation efforts. Voluntary conservation of water was requested earlier in the summer in a few communities having shortages due to a lack of supply or to distribution problems.

The States of Georgia, Florida, and Alabama and the U.S. Army Corps of Engineers formed a drought-management committee to formulate water management action to combat the serious water shortage in the Apalachicola–Chattahoochee–Flint River basin. The committee coordinated many actions taken by the member organizations in response to the drought including reduction in reservoir releases, which reduced hydropower generation and releases for navigation, implementation of water-conservation measures, and water-use restrictions when necessary.

In South Carolina, voluntary restrictions on water use were requested in numerous municipalities and mandatory water-use restrictions were instituted in Camden and York. In North Carolina, mandatory water-use conservation measures were placed in effect by city officials in Durham, Charlotte, Bessemer City, Cherryville, Stoville, Landis, Hillsborough, Mount Pleasant, Concord, Atlantic Beach, and Orange-Alamane and also by the Orange Water and Sewer Authority. Voluntary conservation was requested in 26 additional systems including Winston-Salem and Greensboro.

Water-use restrictions were imposed by 17 water systems in east and central Tennessee. In August, Alabama requested a reduction in the use of water for some communities in DeKalb, Calhoun, Marion, and other central Alabama counties.

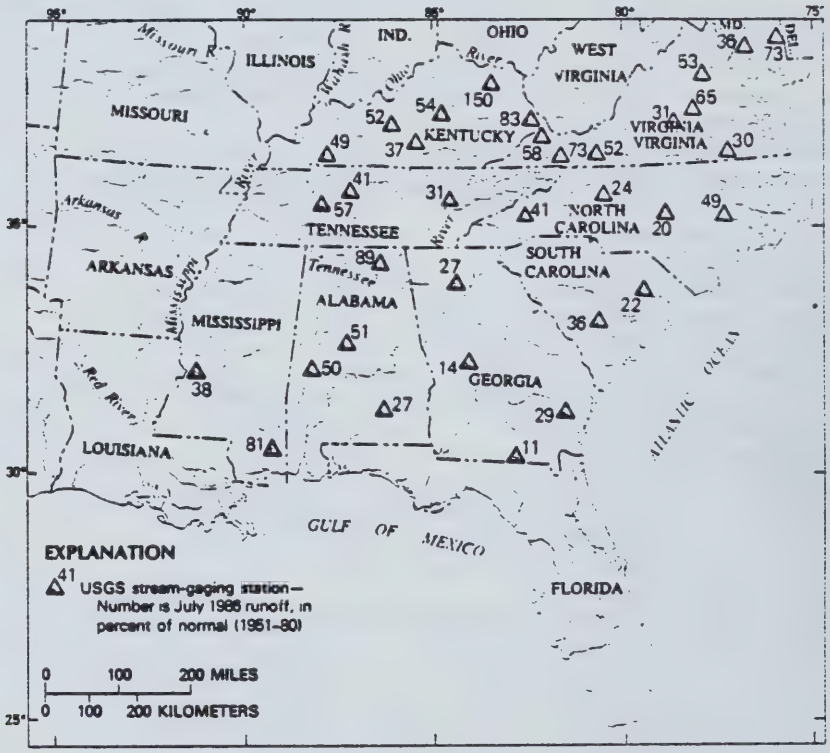

Figure 11. Streamflow for July 1986, the most severely affected month of the 1985–86 drought in the Southeastern United States. (Source: Data from U.S. Geological Survey files.)

By mid-September, many jurisdictions in the Southeast had lifted restrictions because of increased precipitation and the decrease in outside water use.

The 1986 drought also seriously affected hydropower generation in many areas of the Southeast. For example, power generation by the Corps of Engineers' reservoirs in northern Georgia and Alabama was reduced by 50 percent because of reduced streamflow. The Southeast Power Administration, which markets power generation by Corps facilities, was forced to purchase alternative power because of reduced hydropower generation resulting from the drought.

The Tennessee Valley Authority (TVA) reported that for the period January–May 1986, hydropower generation was only 50 percent of normal because of conservation measures at reservoirs in the Tennessee basin. However, increased precipitation, coupled with the conservation measures, produced near-normal

elevations in many of the mainstem reservoirs during early September, permitting a return to near-normal hydropower generation.

The Alabama Power Company reported that hydropower generation was about 70 percent below average in May and about 60 percent below average in June. Hydropower generation in South Carolina was severely reduced because of low reservoir levels. On June 13th a South Carolina company ceased hydropower generation at Lake Murray where generation had been minimal for several months. When the drought eased later in the fall, hydropower generation was resumed.

Figure 12. Lake Sidney Lanier, Georgia, September 1986, at Young Deer Creek embayment on the north side of reservoir near Buford Dam. Water-level elevation was about 1,056 feet above sea level. Tree-line marks near-normal summer elevation of 1,071 feet. In October 1986, the reservoir level had receded to a minimum of 1,054.8 feet, which was only 2.1 feet above the record minimum level of 1,052.7 feet in December 1981. (Photograph courtesy of U.S. Army Corps of Engineers.)

CONCLUSIONS

An agriculturally, meteorologically, and hydrologically severe drought occurred in parts of the Southeastern United States during 1986. The drought began in 1985 in much of Alabama, Georgia, Tennessee, North Carolina, and South Carolina. During 1985 the annual precipitation ranged from 65 percent to 95 percent of normal and the annual streamflow ranged from 50 percent to 80 percent of normal. These dry conditions in 1985 were followed by very low rainfall in the winter and spring of 1986, which resulted in extreme low flows in eastern Alabama, eastern Tennessee, northern Georgia, and the eastern Carolinas during July and August 1986. These low streamflows were less than the previous minimum streamflows recorded at several gaging stations with 50 years or more of record. The timing of these extreme low flows in late July and early August was unusual because annual minimum flows in much of the Southeast usually occur in September and October.

In Atlanta, Ga., the precipitation for the first half of 1986 set a new record low for January-June, and in Raleigh, N.C., and Nashville, Tenn., it was the second lowest January-June on record. The cumulative streamflow through August 1986 was less than 40 percent of normal from Mississippi to North Carolina. In northern Georgia and the eastern Carolinas the streamflows during late July and August 1986 were near the lowest of this century.

Reservoir levels were below normal in north Georgia, east Tennessee, and the eastern Carolinas during the spring and summer of 1986. However, the mainstem reservoirs in the Tennessee River basin were maintained near normal throughout the dry period.

Ground-water levels in the drought-affected area generally were below average. During 1986, water levels in the most severely affected area were below average in the spring and declined to near-record lows in August in many observation wells.

The drought severely affected agriculture, and estimated losses in the Southeast exceeded $1 billion. Many counties in the affected Southeastern States were declared eligible for Federal drought relief. Water-supply shortages occurred in Georgia and the Carolinas as a result of low streamflows and declining ground-water levels.

Water-quality problems occurred in many streams in the Southeast and in the major reservoirs in the Tennessee River mainstem. Fishkills, odor problems, and excessive aquatic weed growth were reported in several States in the Southeast because of the low streamflow and high water temperatures. Most Southeastern States took management actions during this drought emergency and established a variety of drought contingency plans. In some places, particularly in north Georgia and the eastern Carolinas, water use was restricted.

Acknowledgments

The authors acknowledge the contributions of the following U.S. Geological Survey personnel who furnished the information on precipitation, streamflow, ground-water levels, and drought effects for their respective States: J. Brian Atkins, Alabama; A. Carroll Barker, South Carolina; Ronald D. Evaldi, Kentucky; Charles R. Gamble, Tennessee; Timothy W. Hale, Georgia; Catherine L. Hill, North Carolina; Robert W. James, Jr., Maryland; Byron J. Prugh, Jr., Virginia; and E. J. Tharpe, Mississippi.

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SOUTHEAST DROUGHT ACTION REPORT

By: Donald J. Chatelain, P.E.

Submitted for the National Science Foundation's Water Management Workshop of November 1-2, 1988.

The Southeast Drought Action Report (SEDAR) was prepared at the specific request of Robert W. Page, the Assistant Secretary of the Army for Civil Works. The purpose of the report is to briefly describe the impacts of drought, what actions have been taken, activities which are underway, the future outlook, and to suggest what actions might be taken to alleviate or mitigate the impact of drought.

This effort was accomplished through a collective effort of a regional task force. This task force consisted of one representative from each of the following Corps of Engineers offices: Charleston District, South Carolina; Jacksonville District, Florida; Mobile District, Alabama; South Atlantic Division Office, Atlanta, Georgia; Savannah District, Georgia; and the Wilmington District, North Carolina. The geographical area covered in the report was the continental boundaries of the South Atlantic Division of the U.S. Army Corps of Engineers--Florida, most of Alabama, Georgia, South Carolina, North Carolina, the eastern third of Mississippi, a small part of Virginia and a very small part of Tennessee.

Each of the Task Force members were responsible for the overall coordination within their respective offices and regions. Special technical teams were formed to analyze various subject matter contained in this report. These teams in turn discussed drought and potential solutions to the problem with various individuals in the public and private sectors. In all, literally hundreds of individuals from within the Corps of Engineers, other state and Federal agencies, local and state governments, universities and the private sector were consulted during the preparation of this report. A summary of the report follows.

Droughts are nothing new--they have been occurring for centuries. In fact, there are records of drought from Biblical times and discussions on how to plan for drought. The droughts of the 1930's, the "dust bowl" era, and the droughts of the mid-1950's were the most severe and widespread of recent times. The general consensus of water managers and scientists is that the current drought in the southeast, as a whole, began in 1980-81 and continues until today. There is speculation that the drought of the 1980's may approach or even exceed the drought events of the 1930's and 1950's.

The southeast experienced especially severe periods of drought three times in the decade--1981, 1986 and 1988. Agricultural losses due to drought in the southeast in the 1980's are estimated to be $2.5 billion. There were also serious impacts on silviculture, municipal and industrial water supply, hydropower production, recreation, water quality, fish and wildlife, and commercial fisheries. Together all of these impacts, including agriculture, caused economic losses of about $3.5 billion. Perhaps just as important were the intangible impacts of the drought of the 1980's--the hardship of having water hauled on a small scale and rationing of water on a large scale; lake levels which are 20 to 25 percent below normal and stressed groundwater supplies which may lead to even more impact in the immediate future; rising food prices and loss of wages by migrant farm workers; and the impacts to recreation and the environment.

There was a concerted effort in the southeast to respond to the drought of the 1980's. Those involved span the entire spectrum of the population: Federal agencies; state, county, and municipal governments; charitable and civic organizations; private businesses; industries, agriculture; and finally, the millions of individuals who dealt with the hardship of drought. Unfortunately, these drought-related activities have been almost exclusively limited to non-structural measures--conservation, drought management, impact minimization measures, etc. For the most part, there has been very little proactive physical drought-related actions undertaken by either the Federal or non-Federal sectors.

The outlook for the potential impacts of drought in the southeast in the future is not good. The impacts of drought in the future are expected to be much more severe because of the projected increases in population in the southeast with the associated expansion of infrastructure and economic activities through time. In fact, water supply demands are expected to double in the southeast by the year 2020. Water supply demands in some of the major metropolitan areas of the region are expected to increase at a much more rapid rate--in the order of 200 percent in Atlanta, Georgia, 400 percent in Charleston, South Carolina, and 300 percent in the Piedmont counties of North Carolina. Action needs to be taken soon to provide future supplies of water which will help reduce the impacts of drought.

The primary focus of the efforts of the Southeast Drought Action Report (SEDAR) Task Force was in the identification of potential solutions to drought in the near and long term. Many of the ideas generated are far beyond the spirit of current policy and laws and, in many cases, are probably not in the Federal interest. Nevertheless, these ideas do offer us food for thought on how we might best deal with the problems of drought. For this reason, the SEDAR Task Force felt that a comprehensive presentation of all of these ideas was appropriate. This will give decision-makers a wide range of potential solutions to consider when formulating national policy on drought control. The more promising actions identified which could be undertaken by the Federal sector to minimize the impact of drought are summarized below.

- Prior to undertaking any actions, the SEDAR Task Force felt that an updating and consolidation, and perhaps additional studies, of all information on water assessment and conservation should be accomplished to establish a framework for future action. A joint Federal/non-Federal effort is suggested.

- Consider providing technical assistance to states and local governments in the development of water supply augmentation measures. This assistance would be in the form of providing technical expertise to local interests in the construction of water augmentation measures.

- Consider providing financial assistance to local governments for local construction of water augmentation measures. This assistance could come in the form of low interest loans or the Federal purchase of additional storage in locally constructed projects.

- Consider providing supplemental funding to expedite the preparation of drought management plans for all river basins.

- Consider adopting a national policy for the construction of a full range of water supply augmentation measures with appropriate cost sharing.

- Consider adopting a national continuing authorities program for drought. This would allow flexibility in the preparation and response to drought.

- Consider adopting a national emergency drought action program or expanding the P.L. 84-99 emergency authorization.

Cost sharing and the Federal interest in the ideas suggested above will have to be a Washington-level decision. Nevertheless, the SEDAR Task Force felt obligated to offer its collective view, from a field operating office perspective, on the most prudent allocation of any Federal funding which might be considered. The first priority would be to provide supplemental funding for drought management planning. Some of these studies are either completed or underway within available funds. Supplemental funding is suggested because of the potential of drought management planning in minimizing the impact of drought in the near term.

Beyond drought management planning, it was the SEDAR Task Force's judgment that the following actions would produce the greatest net return on Federal investments on drought.

- Technical Assistance. Federal investment would be limited to providing some degree of technical expertise to states and local governments in the planning, design and construction of local water supply augmentation measures. This would limit Federal expenditures since there would not be a partnership in the actual construction. The program would offer two main advantages: first, it would increase non-Federal interest ability to construct more efficient projects and, second, it would help identify potential additions to local projects which could provide additional water for drought reserves.

• Water Assessment/Water Conservation. There has been a great deal of water conservation and assessment studies made. However, there is a need to update and consolidate that information and identify data gaps which should be further analyzed. This would provide a framework for a regional approach to drought, and thus yield a more efficient foundation for both ongoing and future efforts.

• Water Supply Augmentation Measures. There is a very debatable question on the Federal interest in developing a full range of water supply augmentation measures. The Federal interest can only be addressed at the Washington level. The SEDAR Task Force, however, felt that this action needs to be surfaced because of its enormous potential in combating droughts in the future. In fact, there are many of the opinion that this is the only program which will effectively combat major drought on a broad, regional and national scale. This is especially true for prolonged major droughts which may occur in the next century.

• Financial Assistance. There is also a serious question of Federal interest in providing financial assistance to local and state governments in the construction of water supply augmentation measures. The SEDAR Task Force offers this idea for consideration because such a program could provide, to some degree, widespread relief from drought with limited Federal investment. The scope of the financial assistance given will determine its ultimate cost. This assistance could be in the form of low interest loans or purchasing additional storage at locally constructed projects.

• Continuing Authorities Program for Drought. The current Federal program on drought is mostly limited to reaction to drought after or during its occurrence. This program would provide a limited continuing authority to prepare for drought prior to occurrence and then to follow through during drought. Thus, field operating units would be able to construct small projects in advance of drought; inventory available equipment and supplies and then purchase needed emergency items; and develop a mobilization strategy to be in a readiness posture to cope with drought.

• Emergency Drought Action (Reaction) Program. This program could be incorporated in the previously mentioned Continuing Authorities Program for Drought. The SEDAR Task Force offers this suggestion as a separate program since it would be less costly (and less effective) than the Continuing Authorities Program. If adopted alone, this effort would be best administered through appropriate modification and funding of the P.L. 84-99 emergency authority.

Falls Lake
Neuse River Basin, NC
DROUGHT CONTINGENCY PLAN
July 1988

Max B. Grimes, Chief
Army Corps of Engineers, Wilmington, NC

INTRODUCTION

The purpose of this report is to (1) provide a platform from which to make decisions on implementation of water conservation measures during future droughts, (2) review the operational flexibility of Falls Water Control Plan in a drought, and (3) address the potential problems associated with an extreme drought. A severe drought in the Neuse River basin develops over a fairly long period of time and has a typical duration of 6-12 months. Adequate time will be available to plan specific details of a drought operation. Therefore, this plan is an outline of water management measures and coordination actions to be considered when a severe drought occurs. Details of particular water management measures and the timing of their application will be determined as the drought progresses.

BACKGROUND

Usually, the demand for water is the greatest when the natural supply is the least. Falls Lake has been drawn below elevation 246 feet m.s.l. in each calendar year since completion of permanent impoundment on December 7, 1983. Table 1 shows the minimum lake elevation for each year since inception of the project.

TABLE 1

Minimum Elevation at Falls Lake Since Permanent Impoundment

Calendar Year	Date	Elevation (ft., m.s.l.)
1984	November 28	245.74
1985	August 16	245.71
1986	August 10	245.40
1987	November 27	245.32

These elevations would indicate that the mid-1980's are representative of a normal dry period. The potential for a serious drought did exist in both 1985 and 1986 due to the fact that Falls Lake was below elevation 246 feet m.s.l. in August rather than in November or December. Operational experience gained during these dry periods plus computer results from 60 years of record including the critical drought of record (1933-1934) were used to develop the drought operational curves on exhibit 1 at the end of this plan. Exhibit 1 should prove to be an excellent guide to follow for monitoring the status of future droughts as well as a tool for implementing water management decisions in the operation of Falls Lake.

Water supply use by municipalities and industries downstream of Falls dam as tabulated by U. S. Geological Survey is provided in table 2. This table illustrates that the current volume of water required for water supply is insignificant as compared to the minimum release requirements of 60-100 c.f.s. (depending on time of year) from Falls dam.

TABLE 2

Neuse River Water Supply Users Below Falls Dam

Municipality	Source of Supply	Amount of Withdrawal MGD (1987)	Population Served
Town of Four Oaks	Neuse River	0.05	1,835
Town of Smithfield	Neuse River	3.50	8,500
City of Goldsboro	Neuse River	3.60	32,000

Industry	Source of Supply	Average Annual Withdrawal in MGD
Nello Teer Co. - Raleigh Quarry #1 ponds	Neuse River, 2 settling ponds	0.03
Burlington Ind. - Wake County	Neuse River	3.00
Weyerhaeuser Co. - New Bern	Neuse River	30.00

Operational experience during this period has also shown that recreational use of the lake begins to suffer once the elevation falls below 249 feet m.s.l. Numerous complaints were received at both the Resource Manager's Office and Rolling View Marina during the low elevation periods primarily regarding shoals and navigational hazards within the lake. While the facilities at Rolling View marina are designed to function at elevations lower than what occurred, there was very little recreational use observed below elevation 246 feet m.s.l. Lake access is available during periods of low lake levels. This is illustrated in table 3 which gives the top and bottom elevation of boat ramps at current and future access areas.

TABLE 3

Elevations of Public Boat Ramps at Falls Lake

July 1988

Location	Top of Ramp Elevation (ft. m.s.l.)	Bottom of Ramp Elevation (ft. m.s.l.)
Access Currently Available:		
Eno River Portage Area	258.0	242.0
Hickory Hill Access Area	260.0	232.4
Ledge Rock Access Area	257.5	241.6
Rolling View (Marina Area)	255.7	233.0
Highway 50 Recreation Area	256.9	232.5
Upper Barton Creek	258.5	235.3
Future Access:		
B. W. Wells	257.0	236.0
Beaverdam Subimpoundment	254.7*	242.5
Holly Point	253.0**	236.0
Rolling View (Camper Area)	256.3	240.0
Rolling View (Sailing Area)	257.0	240.0

Note: All boat ramps were constructed prior to impoundment of Falls Lake, however, all recreation and access areas have not yet been completed. The elevations given are representative of at least one ramp at each location.
* Will be extended to elevation 258.5 ft. m.s.l.
**Will be extended to elevation 256.0 ft. m.s.l.

SUMMARY OF EXISTING WATER CONTROL PLAN

The authorized purposes of Falls Lake are to provide for flood control, water supply, water quality, recreation, and other purposes. The top of the conservation pool is at elevation 250.1 feet m.s.l. At that elevation the mean depth of the reservoir is 12 feet, and the maximum depth is about 50 feet. Allocated storages for Falls Lake are shown in table 4.

TABLE 4

Storage Allocation

	Elevation (Ft. m.s.l.)	Area (Ac.)	Capacity/Jun86 (Ac-Ft)
Top of flood control pool	264	20,810	335,620
Flood control storage	250.1-264	-	220,880
Top of conservation pool	250.1	11,310	114,740
Bottom of conservation pool	236.5	2,600	25,070
Conservation pool storage	236.5-250.1	-	89,670
Sediment storage	200-236.5	-	25,070

Of the total conservation pool storage, 39 percent has been contracted to the City of Raleigh for water supply. The existing water control plan provides for an operation using a rule curve with a normal pool elevation of 250.1 feet m.s.l., November through March and 251.0 feet m.s.l., May through September with April and October as transition months. This is accomplished by releasing inflow up to nondamage flows in the downstream reaches of the Neuse River during floods. During periods of normal flow, releases from the reservoir will equal inflow. A minimum instantaneous flow of about 60 and 100 cubic feet per second will be maintained immediately below the dam November through March and April through October, respectively. Releases will be made from the conservation storage allocated to water quality as necessary to maintain minimum seasonal target flows on the Neuse River at Smithfield of 184 c.f.s. November through March and 254 c.f.s. April through October.

Regulation flexibility is very limited under existing authority. When the lake elevation is in the conservation pool, the project will be operated to meet water supply and water quality low flow releases. About the only available flexibility from a regulation viewpoint in this situation would be that either the State of North Carolina or the City of Raleigh modify their demands.

Storage-use flexibility between the conservation and flood control pools is not a viable option within the guidelines authorizing the project. Flexibility within the conservation pool between water supply and water quality would have to be initiated and addressed by the State of North Carolina and the City of Raleigh.

ANALYSIS OF DROUGHT OPERATION

Dry periods occur randomly during any time period. There is no major indicator to distinguish "normal" dry periods from severe droughts. Conditions may vary slightly depending on the time of year, length of time the lake is below elevation 250.1 feet m.s.l., and water supply and water quality requirements. However, exhibit 1 and a water budget (which will be generated and maintained by the Wilmington District) outlining water quality and water supply storage remaining will be used to initiate action.

If the elevation drops into Zone C, exhibit 1 or the remaining water supply or water quality storage volume falls below 45 percent as indicated by the water budget, then coordination between all concerned parties shall be initiated by the Wilmington District.

The Drought Management Committee shall consist of the Wilmington District and other Federal agencies as required. Advisors to the committee will be representatives from the State of North Carolina, City of Raleigh, and local governments. Coordination activities shall include but not be limited to initiation of the drought contingency plan, alerting recreation interests within the lake, opening gates on intake tower at Beaverdam Creek (a subimpoundment of Falls Lake), issuing forecasts of water supply and water quality storage remaining, implementing conservation measures, and making public information releases.

The Division of Water Resources with the Department of Natural Resources and Community Development will act as the point of contact for the State of North Carolina for low-flow water quality releases and as the responsible party for notifying all related concerned interests. The Utilities Director for the City of Raleigh, North Carolina, will be the point of contact for the water supply requirements and the party responsible for notifying all related concerned interests about water supply. The Resource Manager for Falls Lake will be responsible for notifying all related concerned interests within the lake (marina operation, recreation use areas, etc.) of the current status and forecast of drawdown. Water Control Management of the Wilmington District shall prepare a water budget of water supply and water quality storage remaining and a forecast of time remaining at the then current usage rate for water quality and water supply. This forecast and water budget shall be updated on a weekly basis and furnished to the resource manager at Falls, the Utilities Director with the City of Raleigh, and the Director of Water Resources with the State.

Public press releases shall be made on an "as-needed" basis through the Public Affairs Office (PAO) in the Wilmington District. These statements shall provide the public with a full explanation of drought operations and forecasts of expected conditions in an effort to reduce inquiries from recreation and concerned interests.

A drought situation report for Falls and other projects within the Wilmington District shall be prepared as appropriate by the Reservoir Regulation Section of the Wilmington District. This report shall provide detailed information on current and forecast situations for informational purposes of District and South Atlantic Division elements.

DROUGHT MANAGEMENT PLAN

This plan may be initiated by the Water Control Manager of the Wilmington District Corps of Engineers when the elevation at Falls is in Zone C on exhibit 1. If not previously implemented, this plan shall automatically become operational and remain in effect any time Falls Lake elevation is in Zone D of exhibit 1.

1. A water budget shall be initiated by the Wilmington District (retroactive to the date that the lake first dropped below elevation 250.1 feet m.s.l.)

2. The City of Raleigh and State of North Carolina shall be updated by the Wilmington District Corps of Engineers on a weekly basis regarding water quality and water supply storage remaining.

3. When 23 percent of either the water quality or water supply storage remains, the responsible agency shall be notified by the Wilmington District that implementation of water conservation should be considered.

4. Whenever the elevation at Falls Lake is drawn down to Zone D of exhibit 1, the following action shall be initiated.

a. All gates on the intake structure in Beaverdam Creek subimpoundment will be opened by the North Carolina Division of Parks and Recreation as directed by the Wilmington District. (The State of North Carolina manages this area as part of a general lease agreement between the State and the Corps for Falls Lake.)

b. The Drought Management Committee will convene to discuss a course of action for the continued operation of Falls and possible alternatives (examples listed in step 5.)

5. Once step 4 has been reached, the plan of action will depend on decisions that must be made by the City of Raleigh and the State of North Carolina, since all storage within the conservation pool at Falls has been allocated to water supply and water quality control. Potential alternatives available to the City of Raleigh and/or the State of North Carolina once step 4 of the management plan has been met include, but are not limited to, the following:

a. Implement restrictive water use measures for personal and emergency use only (no water for lawns, gardens, pools, car washes, etc.)

b. Temporarily relax state standards for water quality requirements in the river below Falls to permit continued operation of industrial and municipal waste treatment facilities, and conserve remaining water quality storage.

6. Should the elevation of Falls Lake fall into Zone E of exhibit 1 or all water supply or water quality storage become depleted, potential alternatives include but are not limited to:

a. Emergency reallocation by the District Engineer in Wilmington of any water that may remain within the Sediment Storage pool.

b. Declaration by the State of North Carolina of a water emergency as authorized by G.S. 143-354. After a water emergency has been declared by the Environmental Management Commission, the Commission can order emergency diversions to meet the needs of human consumption, necessary sanitation, and public safety. The Division of Water Resources assesses water supply problems and recommends action to the Commission under this statute.

SELECTED FEDERAL EMERGENCY AUTHORITIES PROVIDING DROUGHT ASSISTANCE

The responsibility for providing an adequate supply of water to inhabitants of any area is basically non-Federal. Corps assistance to provide emergency water supplies will only be considered when non-Federal interests have exhausted reasonable means for securing necessary water supplies, including assistance and support from other Federal agencies.

Assistance may be available from the Corps through PL 84-99 as amended by PL 95-51. Before Corps assistance is considered under PL 95-51, the applicability of other Federal assistance authorities should be evaluated. If these programs cannot provide the needed assistance, then maximum coordination should be made with appropriate agencies in implementing Corps assistance. The applicability of programs administered by the following Federal agencies, as a minimum, will be determined prior to consideration of Corps assistance.

1. Small Business Administration (SBA).

2. Farmers Home Administration (FmHA).

3. Economic Development Administration (EDA).

Corps Authority for Drought Assistance

The Corps authority for Drought Assistance is contained in Chapter 6, "Emergency Water Supplies and Drought Assistance" of Engineering Regulation 500-1-1 Natural Disaster Procedures (1983). Under this authority, the Chief of Engineers, acting for the Secretary of the Army, can construct wells and transport water to farmers, ranchers, and political subdivisions within areas he determines to be drought-distressed.

Well Construction: Well construction may be provided by the Corps on a cost reimbursable basis. The guidelines for exercising this authority are described as follows.

a. Assistance to an eligible applicant by the construction of well may be provided on a cost-reimbursable basis if:

(1) It is in response to a written request to District Engineer by a farmer, rancher, or political subdivision for construction of a well under PL 84-99 (amended).

(2) The applicant is located within an area which has been determined by the Secretary of the Army to be drought-distressed.

(3) The Secretary of the Army has made a determination that:

(a) The applicant, as a result of the drought, has an inadequate supply of water.

(b) An adequate supply of water can be made available to the applicant through the construction of a well.

(c) As a result of the drought, the well could not be constructed by a private business within a reasonable time.

(4) The applicant has secured the necessary funding for well construction from commercial or other sources and has entered an agreement to pay to the United States the reasonable cost of such construction, or has entered into an agreement to pay to the United States the reasonable cost of such construction with interest over a period of years, not to exceed 30, as the Chief of Engineers deems appropriate.

(5) The applicant has obtained all necessary Federal, state, and local permits.

b. The financing of the cost of construction of a well by the Corps under this authority should be secured by the project applicant. In cases where the applicant cannot secure the necessary funding from commercial or other sources, the Corps may enter into an agreement requiring the applicant to pay the United States the reasonable cost of such construction, with interest, over a number of years, not to exceed 30, as the CDR USACE deems appropriate. The rate of interest shall be that rate which would apply if the amount to be repaid was a loan pursuant to Section 7(b)(2) of the Small Business Act, PL 85-536 (15 U.S.C. 636). Eligibility criteria for a loan will be in accordance with the practices of the Small Business Administration.

c. The project applicant will provide the necessary assurances of local cooperation, to include the normal a-b-c provisions, prior to the start of Corps work under this authority.

d. Equipment owned by the United States will be utilized to the maximum extent possible in exercising the authority to drill wells. Federally-owned well drilling equipment can only be used when commercial firms cannot provide comparable service within the time needed to prevent the applicant from suffering increased hardship for the effects of an inadequate water supply. Use of equipment owned by non-Federal interests would only be appropriate in the unusual circumstance when both of the above conditions can be met.

Water Transport: For the Corps to transport water as assistance during drought, the following guidance is provided.

a. Assistance to an applicant in the transportation of water may be provided only if:

(1) It is in response to a written request by a farmer, rancher, or political subdivision for transportation of water under PL 84-99 (amended).

(2) The applicant is located within an area which has been determined by the Secretary of the Army to be drought-distressed.

(3) The Secretary of the Army has made a determination that, as a result of the drought, the applicant has an inadequate supply of water

for human and livestock consumption and water cannot be obtained by the applicant.

b. Transportation of water by vehicle, small diameter pipeline, or other means will be at 100 percent Federal cost.

c. Corps assistance in the transportation of emergency water supplies will be provided only in connection with water needed for human and livestock consumption. It will not be provided in connection with water needed for irrigation, recreation, or other non-consumptive purposes.

d. Corps assistance will not include the purchase of any water nor the cost of loading or discharging the water into or from Government conveyance.

e. Equipment owned by the United States will be utilized to the maximum extent possible in exercising the authority to transport water. Transport of water under this authority cannot be undertaken until the Secretary of the Army has made a determination that water cannot be obtained by the applicant (for reasons other than lack of financial resources) within the time needed to prevent the applicant from suffering increased hardships from the effects of an inadequate water supply."

Water Supply and Emergency Related Authorities

Corps authorities in water supply and related emergencies are described as follows.

Clean Water Supplies: PL 84-99 as amended by PL 93-251 and and PL 99-662 authorizes the Corps to provide emergency supplies of clean water to a location which has a contaminated source of water. Policies related to this authority are presented below and in ER 500-1-1.

a. Any locality faced with a threat to public health and welfare from a contaminated source of water is eligible for assistance.

b. Assistance may be provided after the responsible Corps official has made a finding that the locality is confronted with a source of contaminated water causing or likely to cause a substantial threat to the public health and welfare of inhabitants of the locality. The finding will be based on one or more of the following factors:

(1) The maximum contaminant levels established pursuant to the Safe Drinking Water Act are found to be exceeded.

(2) The water supply has been identified as a source of illness by a state or Federal public health official (the specific contaminant does not have to be identified).

(3) An emergency situation has either resulted in contaminants entering the source on a sufficient scale to endanger health, or has made inoperable the equipment necessary to remove known contaminants. Examples are flooding and chemical spills.

(4) The presence of a contaminant is indicated on the basis of other information available.

c. The contamination may be deliberate, accidental, or natural.

d. The distribution system may be publicly or privately owned.

e. The assistance will be directed toward provision of water for personal hygiene, sanitation and drinking. However, the quantity of water and the means of distribution will be at the discretion of the responsible Corps official, who will consider both the needs of the individual situation and the cost effectiveness of providing various quantities of water.

f. Permanent work must be approved by HQUSACE and must be the most economical means of furnishing temporary water. This does not include minor modifications required to connect temporary supplies. Accomplishment of deferred or deficient maintenance is not authorized.

g. If a locality has multiple sources of water, assistance will be furnished only to the extent that the remaining sources, plus reasonable conservation measures, cannot provide adequate water.

h. Loss of supply cases are not eligible for assistance. However, if a locality with multiple supplies has one source contaminated and loses another source, it is eligible to the extent that the contamination reduces the total water supply after the loss.

i. Water will not be furnished to a business firm for use in its processes, except as incidental to the use of existing distribution systems. This does not prohibit the furnishing of water for drinking by employees and on-site customers. Also, water for preparing retail meals and similar personal needs may be provided to the extent it would be furnished to individuals.

j. The permanent restoration of safe water supplies is the responsibility of local interest.

k. Corps assistance is normally limited to 30 days or until FEMA undertakes the provision of emergency water under its own authorities, whichever is earlier. In unusual cases where either has justification as to how state and local governments cannot provide clean water within 30 days, assistance may be extended by HQUSACE. Such extension requires a formal agreement between the state and the Corps, covering specified services and providing a firm timetable for local interests to provide normal supplies.

l. State and local governments must make full use of their own resources, including National Guard capabilities.

m. Contamination due solely to a drought would be handled under the drought assistance authorization, Section II of this chapter.

n. Requests for assistance must be signed by the governor of the state. Exception: for Indian tribal lands, the Bureau of Indian Affairs will normally request assistance.

o. Cases involving deliberate or accidental contamination will be coordinated with the Environmental Protection Agency before determination of liability and possible legal action. However, the primary concern is protecting the public health and welfare. If necessary, the Corps will provide assistance and later seek recovery of costs through legal action.

p. Military bases and other Federal reservations are not eligible for assistance, except for cost-share participation in a project which assists adjacent areas.

Federal Emergency Management Agency Authority: Under PL 93-288 FEMA has no authority to provide water for drought situations unless there is a Presidential Declaration made for that purpose. Once a Presidential Declaration of a disaster is made, FEMA directs and administers federal disaster assistance authorities. Corps activities for FEMA fall under the Disaster Relief Act Amendments of 1974 (PL 93-288). This legislation authorizes federal agencies to utilize or lend their resources to provide specific types of assistance.

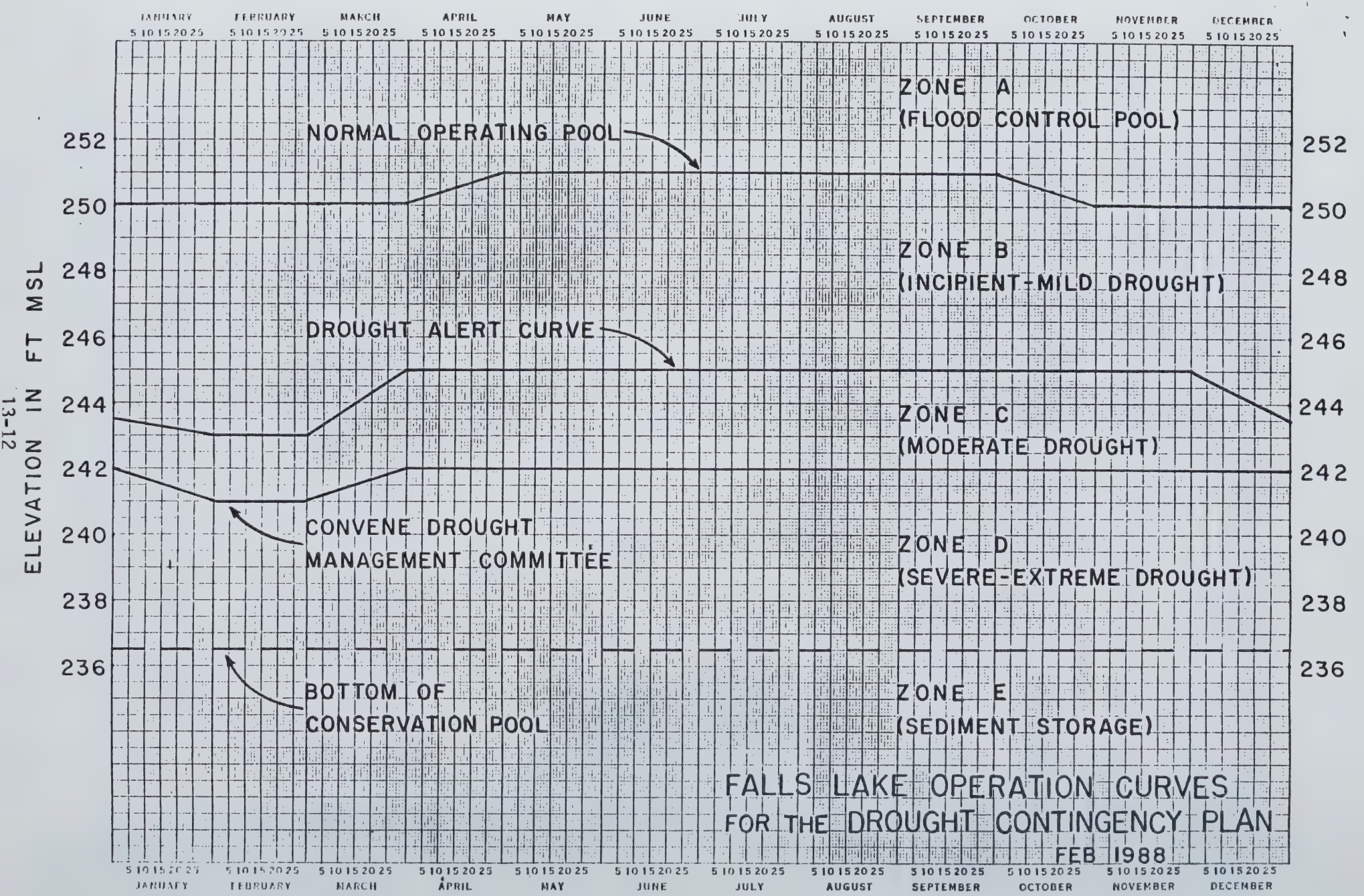

JANUARY 5 10 15 20 25
FEBRUARY 5 10 15 20 25
MARCH 5 10 15 20 25
APRIL 5 10 15 20 25
MAY 5 10 15 20 25
JUNE 5 10 15 20 25
JULY 5 10 15 20 25
AUGUST 5 10 15 20 25
SEPTEMBER 5 10 15 20 25
OCTOBER 5 10 15 20 25
NOVEMBER 5 10 15 20 25
DECEMBER 5 10 15 20 25
ELEVATION IN FT MSL
252
250
248
246
244
242
240
238
236
NORMAL OPERATING POOL
DROUGHT ALERT CURVE
CONVENE DROUGHT MANAGEMENT COMMITTEE
BOTTOM OF CONSERVATION POOL
ZONE A (FLOOD CONTROL POOL)
ZONE B (INCIPIENT-MILD DROUGHT)
ZONE C (MODERATE DROUGHT)
ZONE D (SEVERE-EXTREME DROUGHT)
ZONE E (SEDIMENT STORAGE)
FALLS LAKE OPERATION CURVES FOR THE DROUGHT CONTINGENCY PLAN
FEB 1988

EXHIBIT 1

Water Control Management During Drought
A Case Study: Savannah River Basin, 1987-88

INTRODUCTION

As we approach the 21st century, optimum allocation of our water resources is of vital importance. At no other time is this more apparent than during a scarcity of the resource. The drought conditions in the Southeast over the past decade have severely stressed a system designed to operate under the demands of the sixties, with the needs for flood control, navigation and hydropower being paramount.

The demands in the basin for water supply, water quality requirements and recreational opportunities make what was initially a simple operational procedure very complex. The 1987-88 drought has challenged traditional water management procedures and resulted in innovative scenarios to manage a water shortage.

GENERAL

The Savannah River, formed by two rivers which have their headwaters on the southern slopes of the Blue Ridge Mountains in North Carolina, forms the boundary between Georgia and South Carolina from the North Carolina state line to the Atlantic Ocean. The Savannah River Basin is a long, relatively narrow basin with a total basin area of 10,579 square miles.

Like most large rivers of the Southeast that flow into the Atlantic Ocean, the Savannah River embraces three distinct and hydrologically significant areas; the Blue Ridge Mountain geologic province, the Piedmont Plateau, and the Coastal Plains. These physiographic differences create a complex hydrologic system.

PROJECT LOCATIONS

The Corps has constructed three large multipurpose water control projects in the Savannah River Basin for the purposes of hydropower generation, navigation, and flood control. These are Hartwell, Richard B. Russell and J. Strom Thurmond Dams.

Hartwell is the most upstream project, located about 290 miles upstream of Savannah. The project was completed in 1962, and has over 1.4 million acre feet of storage between its normal and minimum pool levels, and 344 mw of capacity.

The Richard B. Russell Dam is the newest of our projects located 30 miles downstream of Hartwell. It has only 126,000 acre-feet of conservation storage, but has 300 mw of conventional capacity. An additional 300 mw of capacity will be installed as pump turbines when construction is completed.

Thirty-eight miles downstream of Russell and 222 miles upstream of Savannah is the J. Strom Thurmond project. It was completed in 1954 and it has over 1 million acre-feet of conservation storage, and 282 mw of installed capacity. Together these three projects supply 55% of the hydropower to the Georgia-Alabama system.

Thirteen miles downstream of Thurmond is the Stevens Creek owned by the South Carolina Electric and Gas Company. It was constructed in 1908 and is a low-head-run-of-the-river project with very little storage capacity. Its value is in the reregulation of peak hydropower discharges from the Thurmond Dam to provide a minimum flow below Augusta.

Further reregulation capability is provided by Savannah District's oldest project on the river, the New Savannah Bluff Lock and Dam. This project constructed in 1936, is 13 miles below Augusta and 190 miles above Savannah. It is the last water control structure on the river between Augusta and Savannah.

CLIMATIC CONDITIONS

The entire decade of the 1980's has been one of recurring drought in the Savannah River Basin. The 1980-81 period is the drought of record in many areas of the southeast. 1986 was probably the most severe short term drought experienced. Above normal rainfall in early 1987, combined with below normal power demand, caused the reservoirs to refill into the flood control pool and led most people to believe that the drought had ended. However, the groundwater and soil moisture deficits had not been fully satisfied; when the rains stopped in late summer and the lake levels fell.

Rainfall was well above normal in February and March 1987, somewhat below normal in April and May, but returned to above normal in June. July and September of 1987 were slightly below normal, with August dipping nearly 40% below normal. Demand for hydropower had been low through June, due to flooding conditions elsewhere in the generation system. This resulted in the Hartwell project being approximately two feet into the flood control pool in July, while Thurmond stayed above its top of conservation pool elevation into August.

Rainfall during October set a new record minimum for the basin of less than one-half inch. Evaporation during the late summer and fall months exceeded the norm. Increased demand for hydropower due to drought conditions elsewhere in the generating system led to higher than normal discharges, especially in September. This combination of factors led to the rapid drawdown of Thurmond Lake, from full pool in mid-August to nine feet below full pool in mid-October. Hartwell likewise experienced a rapid drawdown from two feet above full pool in early July to ten feet below full pool by mid-October.

In November and December, rainfall increased to near normal, but inflows remained far below average. In early 1988, during the traditionally heavy rainfall months of January through April, only about sixty percent of normal was received. This improved inflows to a point where lake levels at Thurmond and Hartwell recovered approximately three feet. This is far less than what was needed to refill the reservoirs and left the basin in a precarious position going into the normally drier summer months.

Rainfall in May 1988 was only about 30% of normal. Rainfall amounts gradually increased, and by September reached normal. Inflows did not recover so quickly due to the large soil moisture deficit. Natural inflow at Thurmond dam reached a minimum in June at just over 1000 cfs. Although inflows slowly increased, tracking after the increasing rainfall, they were only slightly better than 50% for September, when the rainfall was normal.

Evaporation during 1988 was above normal at Thurmond Lake, especially during midsummer, contributing to the falling pool elevations. Evaporation at Hartwell and Russell was near normal for the year, but well above normal during June.

Pool levels continued a steady decline throughout the summer, averaging slightly less than one foot per month at Hartwell and slightly more than one foot per month at Thurmond. Pool levels at Russell fluctuated between zero and two feet above the bottom of the conservation pool. A short period of intense rainfall in early October served to momentarily stabilize the lake levels. However, several months of above normal rainfall will be required for soil moisture and groundwater deficits to be satisfied before the lakes can refill.

CONSERVATION MEASURES

During the fall of 1987, a drought severity index system was being developed for the drought contingency plan. Although the plan had not been completed, the index system as a trigger mechanism for management action had been accepted by the District Drought Coordination Committee. The index had been tested on data from a number of historical droughts as the plan was being developed, but in mid-October 1987 the index was computed on a real-time basis for the first time. The resultant number exceeded 5, and in accordance with the draft plan, the District took steps to reduce the discharge from Thurmond Dam to 5400 cfs. Following approval by the Division office, coordination with Southeastern Power Administration and state agencies, and notification of water users below Thurmond Dam, the flow was reduced to 5400 cfs effective November 7, 1987.

Outflows from the dams were further reduced in February and March 1988, although without official announcement. Local runoff, from the area between Thurmond Dam and the City of Augusta, allowed Savannah District to maintain the announced 5400 cfs at Augusta while discharging approximately 4500 cfs from the dam.

By the end of March it had become apparent that the spring rainfall would be insufficient to raise the pools more than a few feet. The indexing system had been abandoned due to its complex and time consuming nature. A replacement system of using lake levels as an index was being developed. Projections made at that time showed that if the drought continued at its current severity, the conservation storage would be exhausted around the end of the year. It was recommended that the discharge from Thurmond Dam be reduced to 3600 cfs in order to preclude the pools from being used entirely during the summer and fall season. Following coordination with state agencies and SEPA the Thurmond discharge was reduced to 3600 cfs on April 6, 1988. The Hartwell discharge was commensurately reduced to 2100 cfs.

SAVANNAH RIVER BASIN DROUGHT COORDINATION COMMITTEE

In order to make informed and sound decisions in the management of the resources of the Savannah River Basin, it is necessary that those affected by water management decisions be given the opportunity to provide input to the decision making process.

Successful implementation of the District's drought plan requires the full and cooperative participation of the Savannah District and the South Atlantic Division of the Corps of Engineers and agencies within the states of Georgia and South Carolina. The involvement of these entities is through a Drought Coordination Committee. The purpose of the committee is to coordinate the drought management actions of the States and the Corps, and to develop management recommendations for implementation by their respective agency heads. The Committee serves in an advisory capacity only and is not empowered to make binding decisions for either the States or the Corps.

Membership. The Savannah River Basin Drought Coordination Committee consists of a representative from each of the following organizations:

ORGANIZATION	OFFICE
Savannah District	Engineering Division
South Atlantic Division	Engineering Division
Georgia	Environmental Protection Division, Department of Natural Resources
South Carolina	Water Resources Commission

Responsibilities. Each of the state representatives on the Drought Coordination Committee is responsible for coordinating with the appropriate agencies and local governments within their respective states. Similarly, Corps representatives are responsible for coordinating with appropriate Federal agencies, private power companies, and lake concessionaires and lessee.

Federal agencies most involved in drought water management decisions are the Department of the Energy's Southeastern Power Administration, and the National Weather Service's Southeast River Forecast Center. Coordination is maintained, as appropriate, with the U. S. Fish and Wildlife Service and the National Marine Fisheries Service to assure that impacts to fish and wildlife resources are considered.

The South Atlantic Division's representative coordinates with other Corps Districts whose jurisdictional boundaries border the Savannah River drainage basin and whose water regulation activities could be impacted by drought management actions within the Savannah River Basin. Frequent public announcements in the form of "drought bulletins" serve as an important mechanism for communicating to the various segments of the public water shortage conditions. The "drought bulletins" are agreed upon by the committee. Each committee member disseminates the bulletins to those interests which he/she represents.

The SRBDCC has no enforcement responsibilities. Such activities continue to be the responsibility of appropriate state and local governmental entities. Existing state and local drought plans are implemented as needed and the committee encourages governmental entities to undertake appropriate actions at the local level.

Successful implementation of the Savannah River Basin Drought Coordination Committee's recommendations depends upon efficient and effective internal coordination within the Corps and institutional bodies within each of the States.

Meetings. The SRBDCC meets at least twice a year, to insure that coordination links remain viable. These meetings are normally held in late April or early May, following the winter and spring flood period, and in August, the beginning of the traditional low water period. These are appropriate times to appraise the conditions of the Federal impoundments within the basin and to develop projections for anticipated future conditions.

Once a significantly dry situation has been determined to exist, within either the entire basin or a significant portion of the basin, the Committee will hold a "water shortage appraisal meeting." Any of the four participating parties has the authority to call this initial meeting. To monitor the status of the water shortage conditions, appraise the success of previous measures, and determine appropriate future management measures, the committee meets monthly until conditions return to normal. Should conditions indicate a continuing trend toward a more severe water shortage, the committee will declare a "drought alert" for the basin. The "drought alert" will remain in effect until the committee collectively determines that the situation has improved. Prior to issuance of an "alert," the individual SRBDCC members coordinate these actions within their respective organizations, as well as other interests which could be affected by the various water shortage management measures.

DISTRICT DROUGHT COORDINATION COMMITTEE

Authority. The District Drought Coordination Committee (DCC) will review staff recommendations for District actions required during a drought and make recommendations to the District Engineer on appropriate District actions. It will recommend to the District Engineer, the type, content, and timing of information to be provided to the public about the Savannah District's drought responses.

The District Drought Coordination Committee is chaired by the Chief, Engineering Division, and vice-chaired by the Chief, Hydrology and Hydraulics Branch.

Membership. The District Drought Coordination Committee consists of a representative from each of the following staff elements:

Deputy for Civil Works
Emergency Management
Hydrology and Hydraulics (EN-H)
Operations Division
Planning Division
Public Affairs
Real Estate Division

The Chief of Engineering Division appoints additional members as necessary to insure broad based input on the committee.

Responsibilities. The Committee Chairman will be advised of problem by the Chief, EN-H. Members of the District Drought Coordination Committee are notified of the onset of each drought alert phase and are provided information by the Chairman with respect to the drought alert phase.

Each member of the District Drought Coordination Committee is responsible for bringing to the attention of the Drought Coordination Committee items within the area of responsibility of their own Division/Office.

Members of the District Drought Coordination Committee may request that presentations on specific issues be made to the Committee by other District personnel.

DROUGHT CONTINGENCY PLANNING

General. The essential first step in any technical analysis is the clear identification of the problem. Unfortunately, a widely accepted definition of "drought" does not exist. Droughts are assessed in a variety of terms by different interest fields. Meteorologists view droughts in terms of below normal precipitation; hydrologists view droughts in terms of below normal stream flow and depleted reservoir storage; agriculturalists view drought in terms of a period during which soil moisture is insufficient to support crops; and, economists view drought in terms of low water supplies that affect society's productive and consumptive activities.

The U.S. Army Corps of Engineers, being a "project" oriented, action agency, must consider drought from the standpoint of the economic and environmental impacts of water shortages. A "bottom line" assessment of drought impacts is appropriate. Consequently, any of the available means of measuring drought such as rainfall, surface and groundwater storage, Palmer Drought Severity Index, soil moisture, etc., should be considered only insofar as they cause economic or environmental damages.

Trigger Mechanisms for Management Actions. The inability to define the beginning of a drought as it is occurring hampers the ability to make appropriate management responses. For this reason, it is desirable to have an indicator or triggering mechanism to initiate management actions before a crisis occurs. Two triggering mechanisms have been used during the 1987-88 drought in the Savannah River Basin.

Drought Severity Index. The Drought Severity Index (DSI) was developed for the Mobile District by Drs. Donald C. Raney, William G. Nichols, and Donald Branses of the University of Alabama for the Lake Sidney Lanier project which is located on the Chattahoochee River upstream from Atlanta. The Savannah District adapted this methodology to fit the conditions of the Savannah River Basin. The monthly DSI is based on a combination of the average rainfall over the previous four months, relative to the normal rainfall, and the current lake elevations, relative to normal lake elevations.

An index number is computed independently for Hartwell, Russell, and Thurmond Lakes. A weighted-average basin-wide index is calculated based on the volume of useable storage in each reservoir. The weighting factors are: Hartwell, 0.55; Russell, 0.05; and Thurmond, 0.40. The DSI scale ranges from 0, for normal water availability, to 10, or higher, for extremely severe water shortage.

As previously mentioned, use of the DSI as a trigger mechanism was abandoned in February 1988 due to its complexity and time consuming nature. The DSI also proved to be extremely difficult to comprehend by those not intimately familiar with its application. Since the use of the DSI was discontinued, its methodology will not be discussed.

Lake Level. In March 1988, the decision was make to use lake levels as the trigger mechanism. Although it does not account for weather factors as do some indicators, it has the advantage of simplicity, readily understandable, and easily implemented. Also, it requires no complex and time-consuming computations. However, it must be stressed that the lake level trigger mechanism serves only as a guideline, since an engineering analysis of unforeseen conditions could justify delaying or accelerating various management actions. Actions to be taken at the various pool elevations range from initiating a public safety information program at level 1 and then progressively limiting discharges until outflow is equal to inflow at the highest action level, level 6.

Table 1 presents the trigger lake level, associated action level, and action to be taken for Hartwell and Thurmond. There are no action levels for Russel because of its relatively small drawdown.

As drought conditions in the basin ease, the reductions in releases will have the effect of refilling the lakes. It was originally planned to incrementally return to normal releases, but later it was decided that refilling the pools was more important. Therefore, conservation measures are expected to remain in effect until the pools are refilled.

Objectives of the Plan. In order to use any triggering mechanism it is first necessary to define the objectives of the drought management plan. The objectives of the drought management plan for the Savannah River Basin are:

Conserve water by limiting releases, in order to preserve the availability of water to maintain minimum water-supply requirements (both in-lake and downstream) during the equivalent of the drought-of-record.

Maintain a minimum release of 3,600 cfs at Thurmond Dam for downstream users. Adjust discharges at Hartwell and Russell to maintain balanced levels with Thurmond Lake.

Minimize impacts to recreation during the recreation season (generally regarded as being May 1 through Labor Day).

Maintain releases required to meet state water-quality standards (7-day, 10-year low flow) for as long as possible to prevent jeopardizing water supplies.

Continue to generate minimum hydropower (with the water required to meet downstream needs.) No additional releases will be made for hydropower purposes.

TABLE 1

Hartwell Action Levels

Level	*** May 1 - Sep 8 (ft-msl)	*** Oct 8 - Mar 1 (ft-msl)	Action
1	656	656	Public Safety Information
2	655	654	Limit Thurmond discharge to 6300 cfs.
3	652	650	Reduce Thurmond discharge to 5400 cfs.
4	651	648	Reduce Thurmond discharge to 4500 cfs
5	650	646	Reduce Thurmond discharge to 3600 cfs

Thurmond Action Levels

Level	May 1 - Sept 8 (ft-msl)	Oct 8 - Mar 1 (ft-msl)	Action
1	326	326	Public Safety Information
2	325	324	Limit Thurmond discharge to 6300 cfs.
3	323	321	Reduce Thurmond discharge to 5400 cfs
4	321	319	Reduce Thurmond discharge to 4500 cfs
5	320	318	Reduce Thurmond discharge to 3600 cfs

***Lake elevations for the periods March 1 to May 1 and September 8 to October 8 are linearly interpolated.

Implementation of the Plan. A number of sequential actions are used at each level as shown in Table 2 to implement the Savannah River Basin Drought Water Management Strategy. These efforts include coordination with the States of Georgia and South Carolina, the establishment of a public information program, monitoring of conditions within the basin, and evaluation of any other actions which may be required to fully implement the strategy.

CONCLUSION

Planning to manage crisis can never be easy, but the many and competing purposes which our projects must serve has made drought management very difficult. While our management and coordination efforts during the 1987-88 drought are continuing, we feel we have in place a water management plan that will meet water supply and water quality needs into the next year should the drought continue for that long.

Through coordination of this plan with water users in the basin we have identified potential problems and have developed plans to address those problems. Our planning can never be complete since conditions in the basin continue to change. Input from all parties to the meteorologic event (drought) is considered and our contingency planning process is on going.

Table 2
Savannah River Basin Management Actions

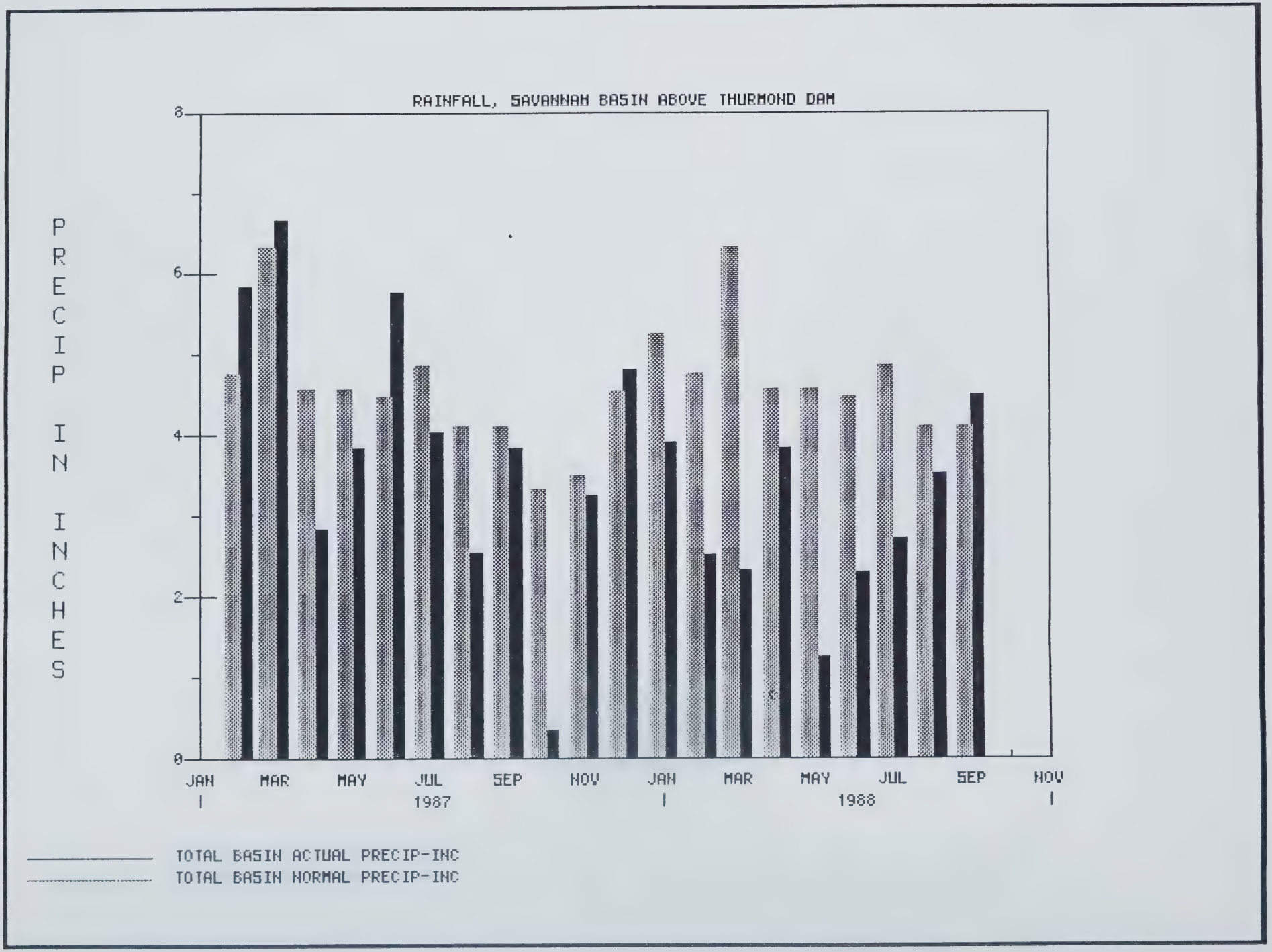
Pool Level	Management Action	*Action Office
Level 1	1. Notify District Drought Coordination Committee.	EN
	2. Prepare news release.	PA
	3. Post notices of navigation hazards.	OP
	4. Close beaches, boat ramps where required	OP
	5. Begin informal discussion with SAD/SEPA regarding reduced generation.	EN/OP
	6. Be alert for worsening conditions.	EN
Level 2	1. Recommend Thurmond release limited to 6300 cfs.	EN
	2. Coordinate action with SRBDCC.	EN
	3. Coordinate action with SAD.	EN
	4. Notify Division Engineer 2 wks. prior to reduction.	
	5. Prepare news release.	PA
	6. Public notice to water users.	OP
	7. Prepare for emergency permit actions.	OP
	8. Coordinate with Congressional delegations.	DD
	9. Limit Thurmond release to 6300 cfs	EN
Level 3	1. Recommend Thurmond release reduced to 5400 cfs.	DDC
	2. Coordinate action with SRBDCC.	EN
	3. Coordinate action with SAD.	EN
	4. Notify Division Engineer 2 wks. prior to reduction.	DE
	5. Prepare news release.	PA
	6. Public notice to water users and local agencies.	OP
	7. Prepare for emergency permit actions.	OP
	8. Coordinate with Congressional delegations.	DD-X
	9. Reduce Thurmond release to 5400 cfs.	EN
Level 4	1. Recommend Thurmond release reduced to 4500 cfs.	DDC
	2. Coordinate action with SRBDCC.	EN
	3. Coordinate action with SAD.	EN
	4. Notify Division Engineer 2 wks.	DE
	5. Prepare news release.	PA
	6. Public notice to water users and local agencies.	OP
	7. Process intake modification permits on emergency basis	OP
	8. Coordinate with Congressional delegations	DD-X
	9. Monitor status of water intakes	OP
	10. Reduce Thurmond release to 4500 cfs	EN
	11. Weekly status report to DE	DE

Level 5	1. Recommend Thurmond release reduced to 3600 cfs.	DDC
	2. Coordinate action with SRBDCC.	EN
	3. Coordinate action with SAD.	EN
	4. Notify Division Engineer 2 weeks prior.	DE
	5. Prepare news release.	PA
	6. Public notice to water users and local agencies	OP
	7. Coordinate with Congressional delegations	DDX
	8. Reduce Thurmond discharge to 3600 cfs.	EN
	9. Weekly status report to DE.	EN
	10. Weekly status report to states.	PD
	11. Coordinate with in-lake withdrawers to lower intakes so lakes can be drawn below minimum conservation pool, if required.	EN/OP
Level 6	1. Analyze results of Action 10 of Level 5.	
	2. Recommend releases set equal to inflows.	

* See Table 1

* List of Abbreviations

DE	District Engineer
DD-C	Deputy Commander
DD-X	Administrative Officer
EN	Engineering Division
OP	Operations Division
PD	Planning Division
PA	Public Affairs
RE	Real Estate
EM	Emergency Management


RAINFALL, SAVANNAH BASIN ABOVE THURMOND DAM
PRECIP IN INCHES
8
6
4
2
0
JAN
MAR
MAY
JUL
SEP
NOV
JAN
MAR
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JUL
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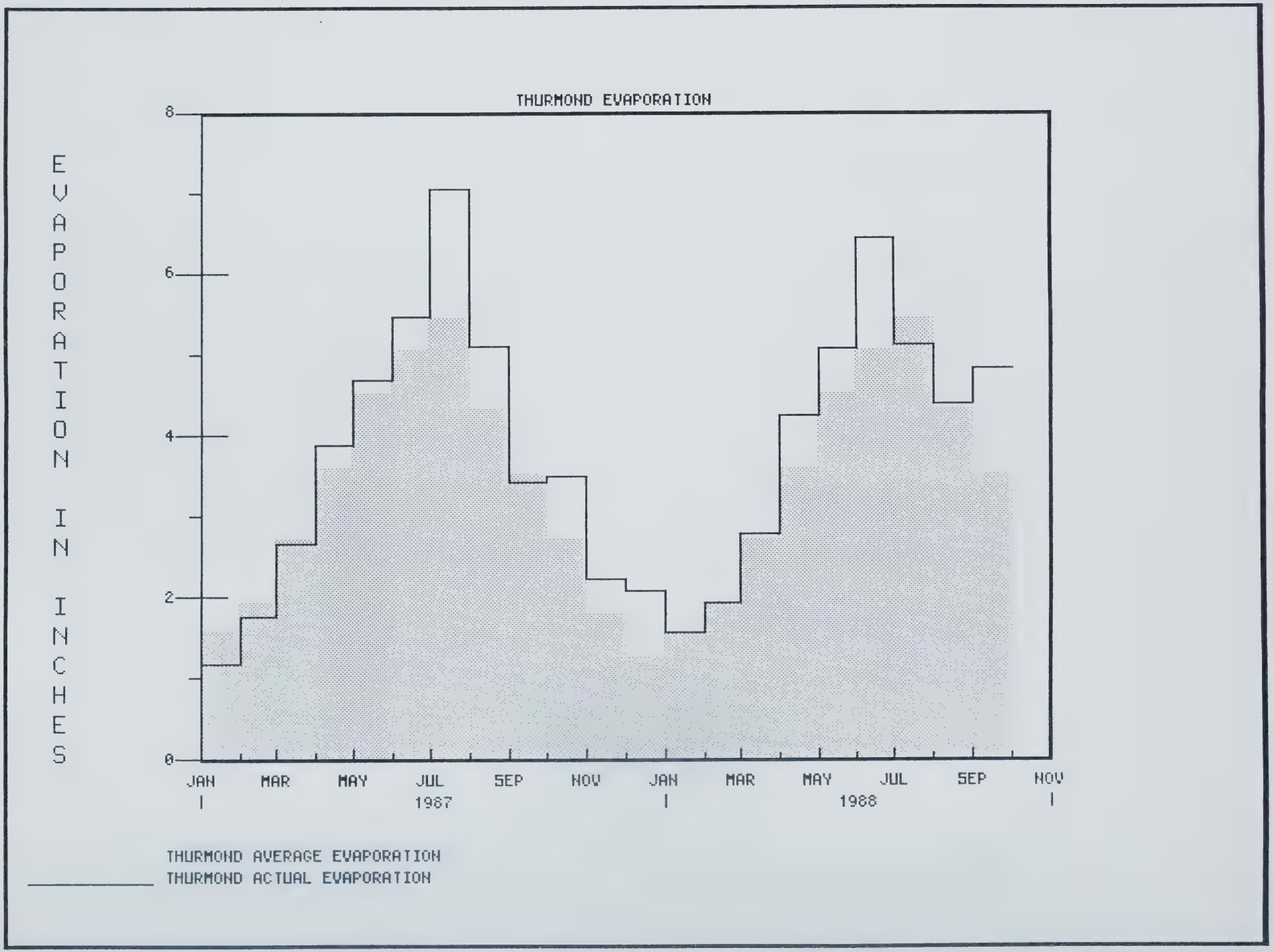
1987
1988
TOTAL BASIN ACTUAL PRECIP-INC
TOTAL BASIN NORMAL PRECIP-INC


THURMOND EVAPORATION
EVAPORATION IN INCHES
8
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JAN
MAR
MAY
JUL
SEP
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JAN
MAR
MAY
JUL
SEP
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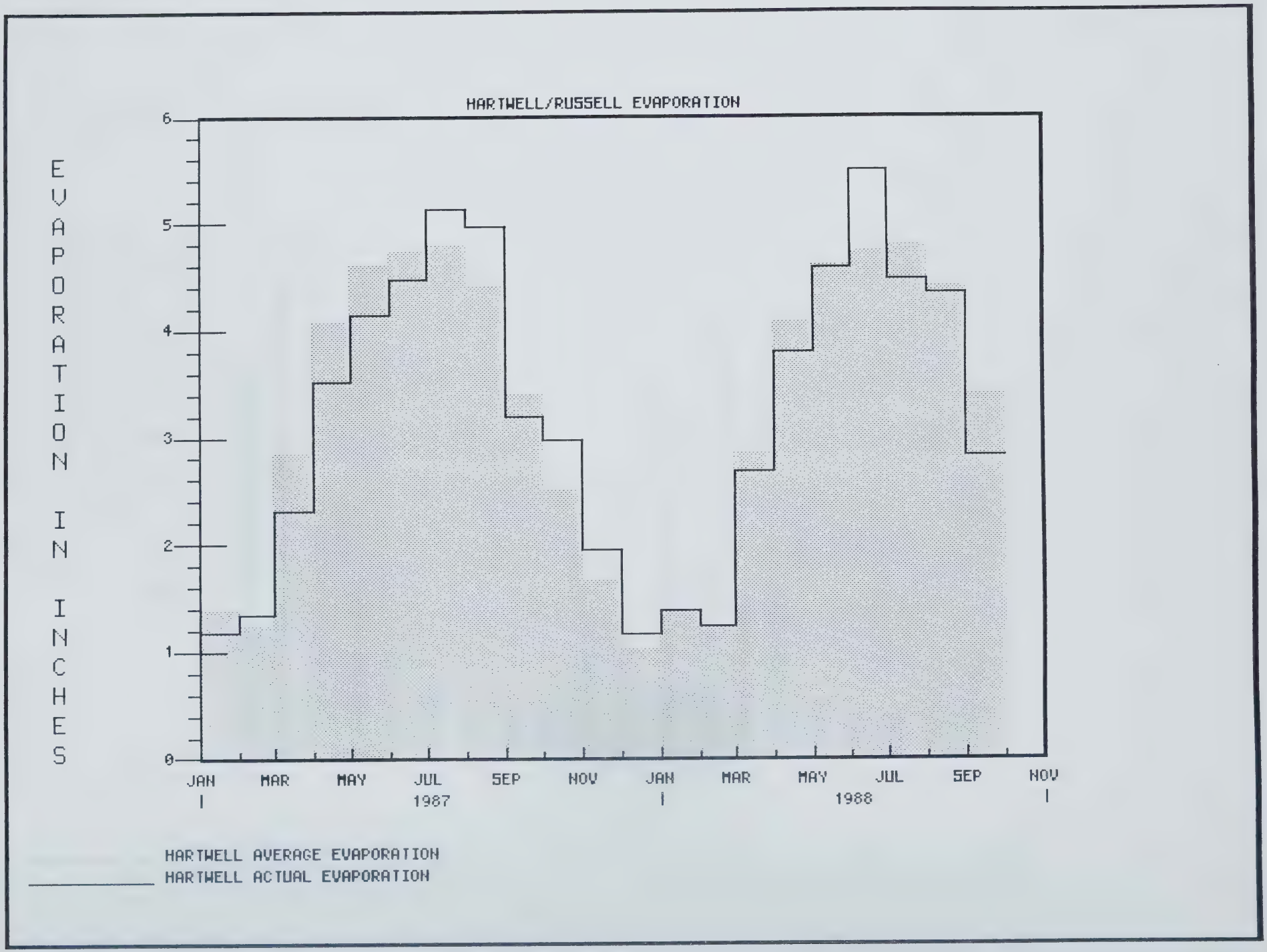
1987
1988
THURMOND AVERAGE EVAPORATION
THURMOND ACTUAL EVAPORATION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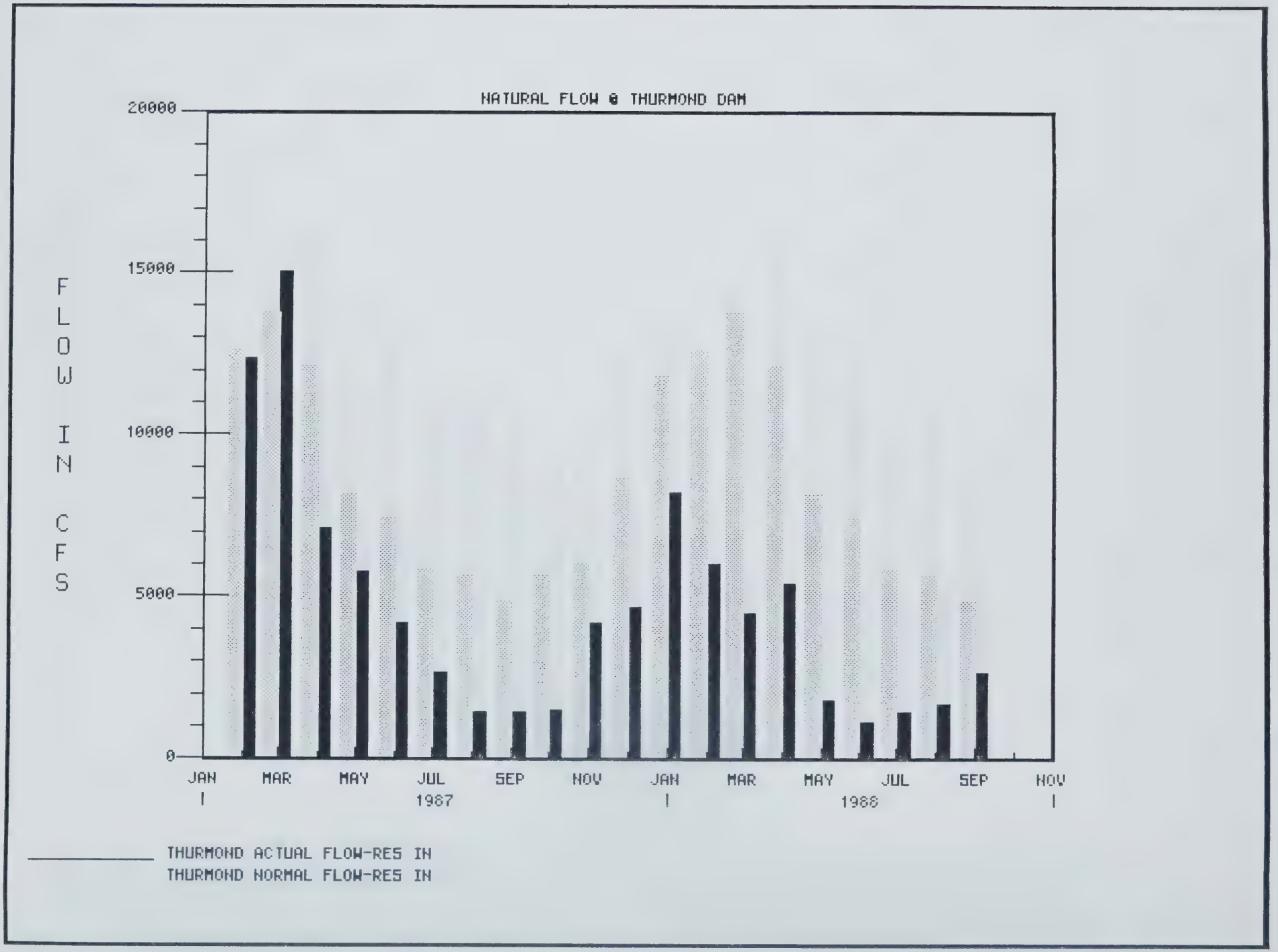
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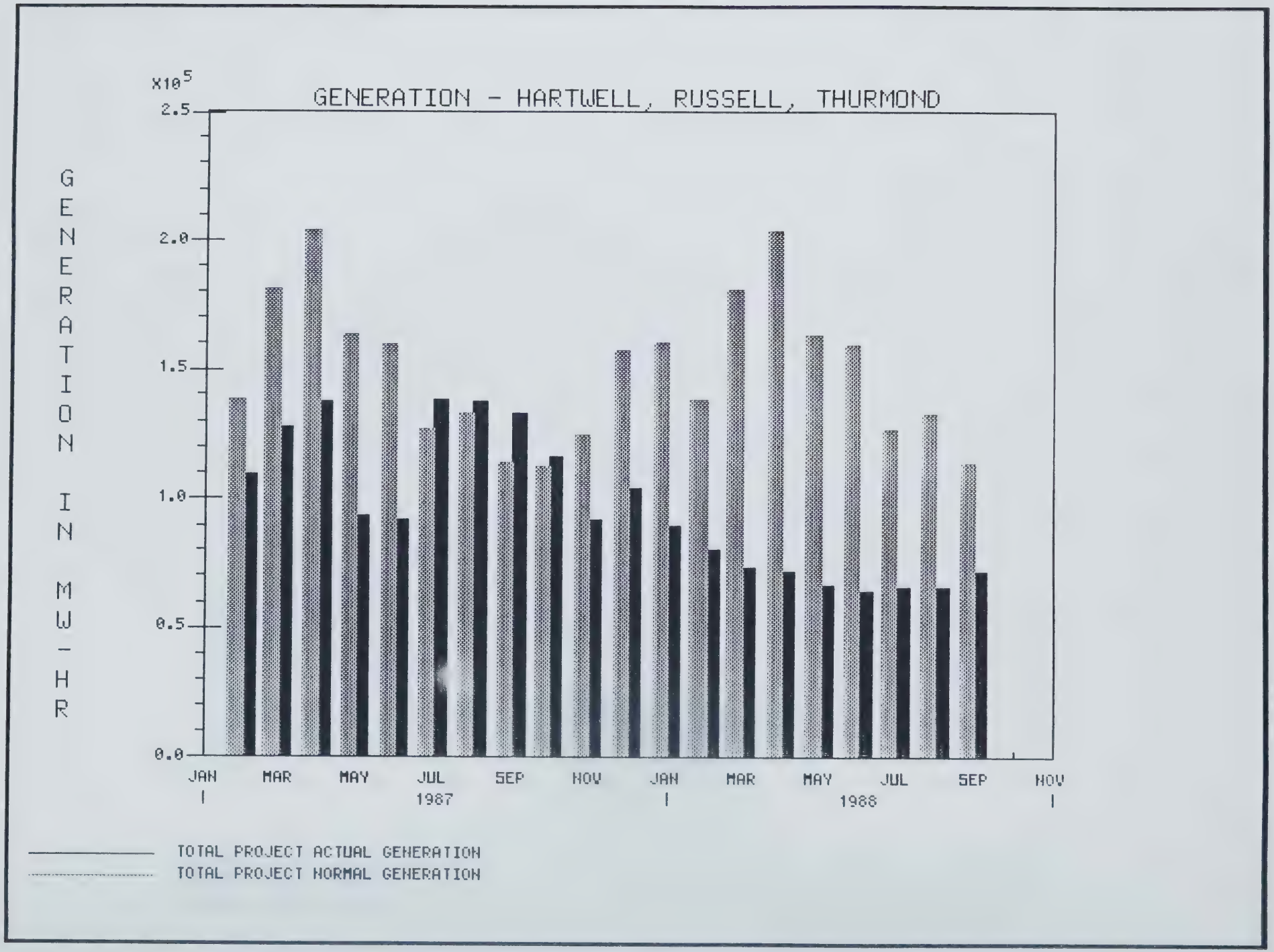
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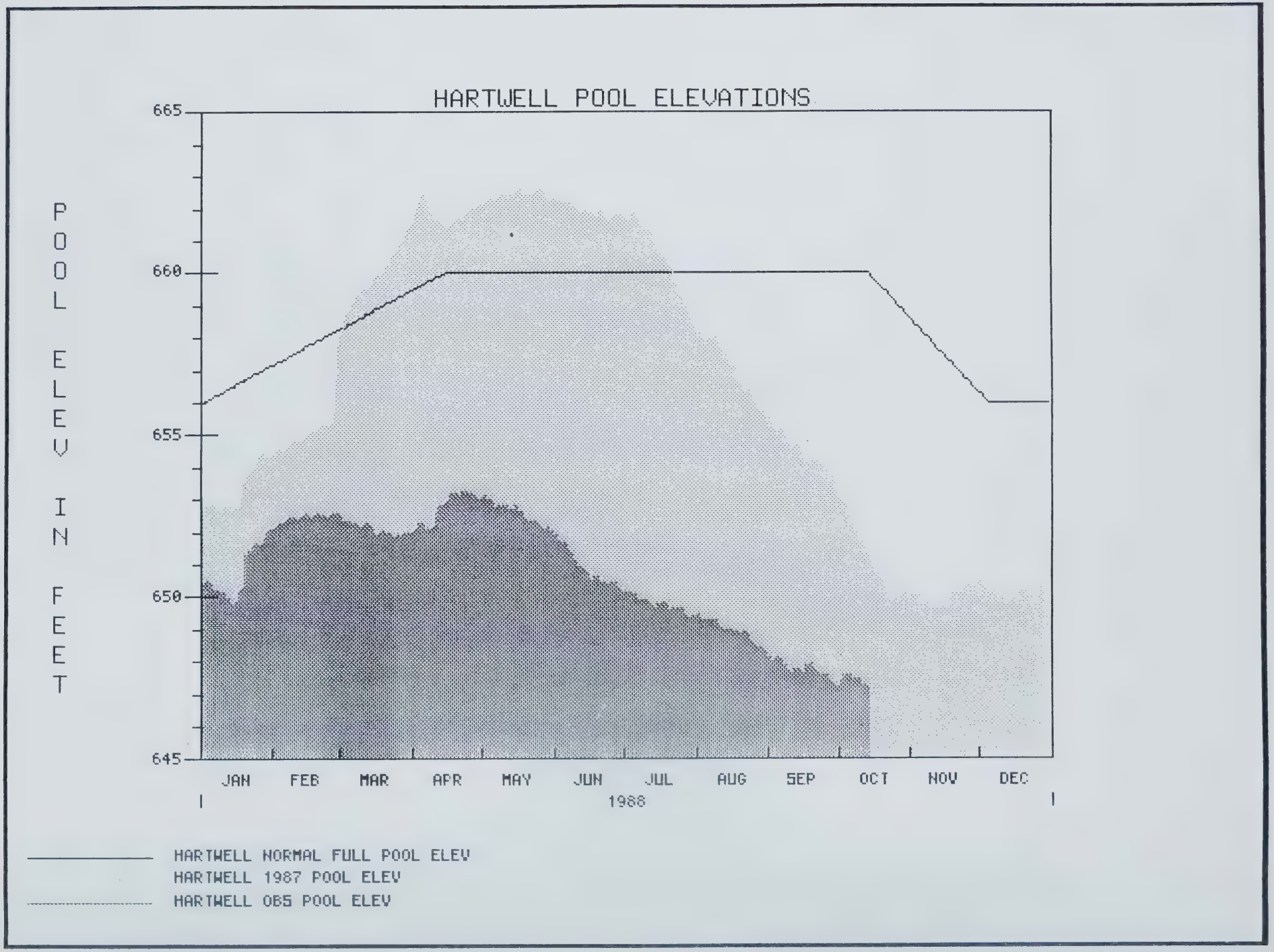
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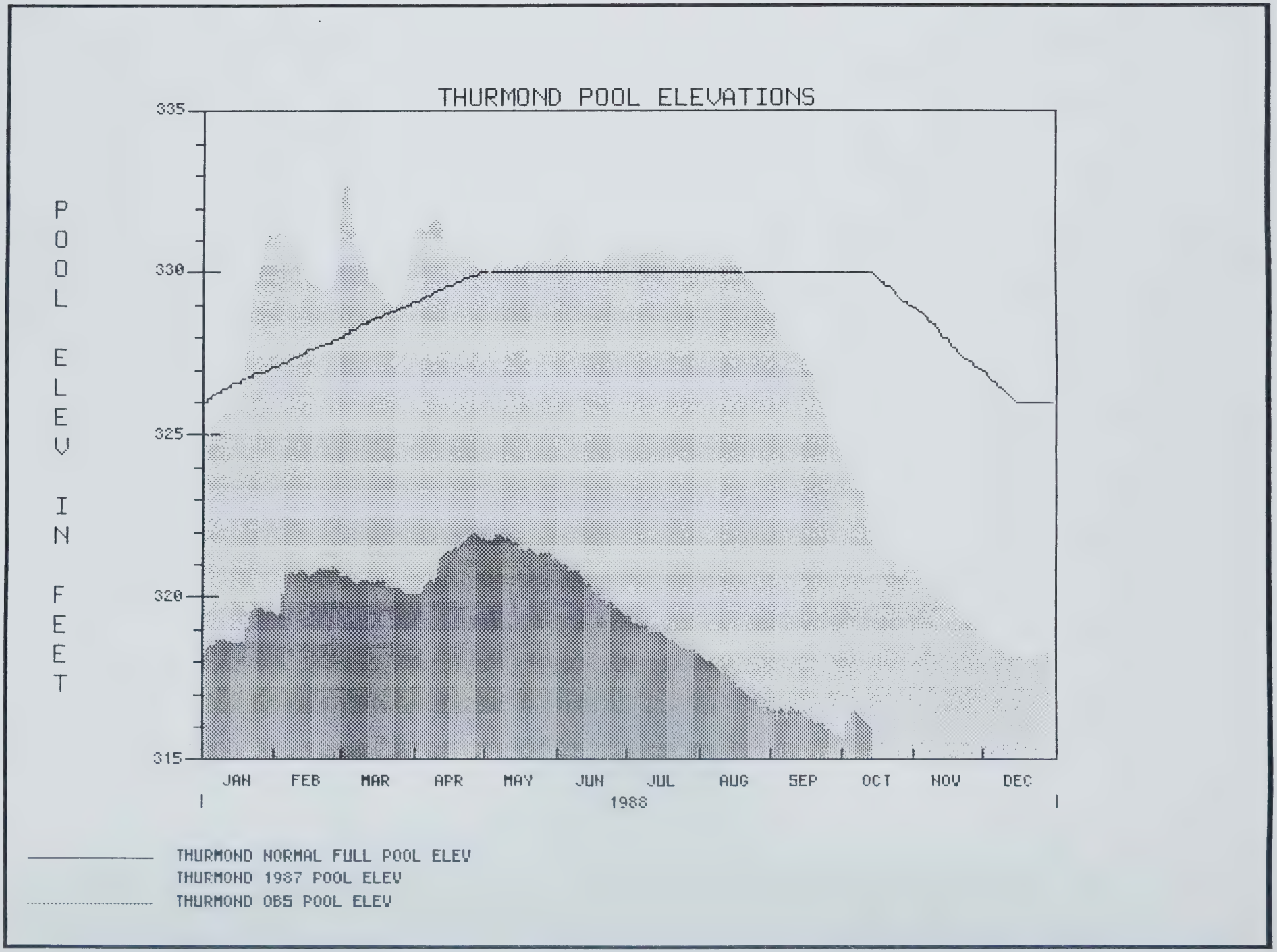
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THURMOND 1987 POOL ELEV
THURMOND OBS POOL ELEV

(16)

TENNESSEE'S MANAGEMENT OF WATER SUPPLIES DURING DROUGHT

by Lee A. Keck

Division of Water Supply

Tennessee Department of Health and Environment

November 1-2, 1988

National Science Foundation Workshop

INTRODUCTION

Both water quantity and water quality are affected by drought. These are major concerns of the Department of Health and Environment, reflecting the agency's mandates to protect water quality and to insure the provision of safe drinking water. In accordance with these mandates, Tennessee's drought management plan recommends that every water user consider all management alternatives based on a thorough evaluation of water sources, facilities and uses of water. Because drought affects each user differently, responses of municipalities, utility districts, businesses, farmers and others to a drought will vary. Also circumstances and needs differ.

Users are urged to consider their source. This should be done within the context of the overall hydrologic cycle. Although Tennessee averages over fifty inches of precipitation each year, about thirty inches of that is taken up by evapotranspiration.

Evaporative loss increases in the summer and fall when it is warm and plants are growing. Annually, about twenty inches either percolates into the ground recharging the ground water or runs off as stream flow. Winter and spring rains restore the ground water resource.

Ground water is especially important to maintaining streamflows during periods of low rainfall. Throughout the summer ground water slowly depletes itself to provide "base" streamflow. Although generally more reliable than streams, springflows and water well yields below seasonal levels can be expected in East and Middle Tennessee during extended dry periods. In West Tennessee, ground water yields from unconsolidated sands are typically less variable and more sustainable because of larger aquifer storage capacity.

The measurement of springs, wells and streamflows over a long period provides a statistical basis from which to predict flows and yields. The low-flow statistic used in water management in Tennessee for unregulated streams and springs is the 3Q20. It is the lowest flow averaged over a three-day period which can be statistically expected to occur once in twenty years.

Pump tests are used to measure water well capacities. These tests also involve detailed analyses of area geology and other factors. Reservoirs are evaluated based on stream inflow, water level, usable storage capacity, evaporation and other information.

Statistical data indicate the degree of risk a stream, spring or water well user may be assuming. The degree of risk of one source may not correlate well with other types of sources because of differences in the ways sources are replenished and used. For example, an "agricultural drought" may occur in years which have low rainfall during the growing season although the rest of the year may be wetter than normal. A near "normal" year in terms of precipitation, following a very dry year, may have lower ground water levels and reduced surface water flows although soil moisture conditions may be adequate for agricultural purposes. Users relying on ground water in these areas might experience a "ground water drought" under these conditions.

Droughts which develop over an extended period of time, including winter and late spring, generally result in limited ground water supplies over the

eastern two-thirds of Tennessee by late summer and fall, as well as limited surface water over the entire state. These conditions are frequently referred to as a "hydrologic drought." Thus, seasonal variation, antecedent conditions and topographic and geologic differences are important considerations in evaluating a source's reliability, its potential to assimilate waste and the management of its use.

The occurrence of surface and ground water in Tennessee is somewhat predictable within physiographically similar areas. Although the severity of drought will vary considerably across the state because of unequal rainfall, seasonal variations in evapotranspiration, differences in topography and soil, drainage patterns and geologic formation, in Tennessee these natural differences in the availability of water correspond to physiographic areas or provinces of the state. These characteristics are important to an area's general outlook and planned response. Although every source is unique, the availability and quality of water in each province is generally predictable under drought conditions. These conditions are important in considering the impacts to sources from discharges and to their use as sources of water.

However, a more site specific description may be needed when a user's water source is critical and must be accurately determined.

Although risk of water shortage is always possible, the toleration of risk will vary among users. Under severe drought conditions, making water available may involve considerable source and facility development. Considering costs, users develop facilities based on whatever level of risk is acceptable to them.

The level of risk is based on source capability, the extent to which it has been developed, and established water needs. Once these are known, users must tailor their plans to manage local resources and demands under drought conditions. A drought management plan can help avert a crisis during a drought.

Because sources and needs vary greatly in Tennessee, there could be no single set of remedies or a plan appropriate to all users. Drought management plans must assess risk, differentiating among uses. The more essential the water supply to a user, the greater the need to reduce risk. Some users, including public suppliers, must determine acceptable levels of service for various uses, given available water resources. Priorities will have to be established for essential needs such as hospitals, nursing homes and firefighting. Preference might also be given to domestic uses, livestock watering and office-commercial use. Impacts to the environment should also be considered.

MANAGEMENT PRINCIPLES

Water shortages are best addressed at the local or county level. Local communities, municipalities, utility districts and county governments can develop water shortage or drought response plans which address local problems and local circumstances. Municipal water systems and other purveyors of water are urged to develop phased plans based on a "stepped" scaling back of water availability. Plans should not only consider remedies addressing source related problems, but should also include the provision of drinking water to

problem service areas and potential treatment and hydraulic problems. Self-supplied water users should also identify responses. County governments may need to haul water for domestic and livestock use to self-supplied water users with inadequate sources. Plans should address both water supply and water quality. Self-supplied water users should also identify responses which address water quality and water quantity problems.

Tennessee's role during a drought is to provide water management information, technical assistance and regulatory oversight. Data collection consists of general indicator data, although water users who depend on particular monitored sources may benefit specifically.

Because of its delegated authority and mandates, the Tennessee Department of Health and Environment serves as the state focal point for hydrologic data dissemination. For example, reservoir water level data obtained from the Tennessee Valley Authority and the U.S. Army Corps of Engineers is made available to the public through the Division of Water Supply. Ground water levels monitored by the United States Geological Survey and precipitation data collected are also obtained and disseminated to the public during drought periods.

Under the State's Safe Drinking Water Act, the Tennessee Division of Water Supply has authority to supervise operations of public suppliers to insure adequate provision of safe drinking water. Where minimum standards are not being met or a locally adopted water shortage management plan is inadequate, the supplier is subject to Orders issued by the Commissioner of the Department of Health and Environment.

The State of Tennessee, through either the Department of Health and Environment or the Tennessee Emergency Management Agency, also works with the Tennessee Valley Authority and the Army Corps of Engineers to modify operations of reservoirs and flows deemed necessary to maintain water quality and economic viability as well as serve other purposes.

Where a local/regional response to a water shortage is inadequate, the Department of Health and Environment would have authority, either independently or through a concurring declaration of emergency by the Governor and the Tennessee Emergency Management Agency (TEMA), to mediate or resolve water use conflicts between competing users, including the protection of the environment. The authority for this power can be found under various statutes and Executive Orders.

Situations will be handled locally to the largest extent possible, although state agencies may become involved in coordinating the efforts necessary to alleviate a local water crisis. Efforts may be directed toward water hauling, laying of temporary pipe, reallocation of water or any other actions necessary for mitigating the emergency. Each emergency will be dealt with as planned and on a case-by-case basis. Where the emergency cannot be resolved by the local water system, the state will consider remedies present within the watershed including the allocation of water between competing users, changes in reservoir management and assistance from nearby systems or communities. Funding of these emergency actions is borne by the local community to the greatest extent possible.

The role of federal and regional agencies in a drought will depend on the water-related resources under their management. In Tennessee, those federal agencies having major responsibilities include the Tennessee Valley Authority, the U.S. Army Corps of Engineers, the United States Geological Survey, the Environmental Protection Agency, the Fish and Wildlife Service and the Soil Conservation Service.

In addition, military units in Tennessee are prepared to provide needed water treatment and water hauling equipment if requested.

PLANNING GOALS

In order to effectively accommodate the public interest, the Tennessee Department of Health and Environment recommends that local drought management plans identify practical goals and objectives.

The goals of a local public water supplier's drought and emergency management plan may include:

1) equitable distribution of available water supplies among all water users during times of drought, minimizing adverse economic, social, environmental, and health related impacts;
2) a basis for management decisions related to the use of water under varying water shortage conditions; and
3) advance knowledge of actions that will be taken during times of water shortage to facilitate plan implementation in a timely and orderly manner and promote greater security among water users.

More specific goals relating to levels of service under each management phase may be included in a drought management plan depending on the circumstances of the system. Where water users have a low tolerance for water use restrictions, the system may need to undertake a long-term investment strategy to reduce the risk of short supplies.

A long-term water development plan to meet growing water needs over an extended period should be part of the supplier's normal planning for growth.

Facilities with large sources and those which are willing and/or able to accept extensive restrictions and cutbacks over longer periods need a drought management plan to be orderly and equitable in the event of a shortage. A really good management plan will deal with unexpected emergency shortages as well as drought.

Creation of an advisory group to be involved in developing a drought management plan is considered critical to the plan's usefulness. An advisory group can provide direction to officials in gathering information related to sources, demand and responses. They may suggest which options are more suitable for reducing demand and explore potential auxiliary sources of

supply, including lakes, quarries, additional wells, etc. They are particularly valuable in identifying potential exceptions to rules and developing policies and approaches which address special needs.

The advisory group can provide much needed support where difficult decisions must be made. They can assist in public education, promote adoption of the plan, organize and oversee its implementation. The group may also oversee interagency coordination and serve an appeals role for granting variances where circumstances are unique. They can also serve as a consensus-building group so that local decisions have general political and community support.

MANAGING USES

Each water user or supplier must evaluate his own source(s), treatment, delivery capacities, and uses. Following the evaluation, each must identify appropriate triggerpoints for drought management. Triggerpoints would be identified for each phase management. The Tennessee Division of Water Supply recommends a minimum of three management phases of increasing restrictiveness: Conservation, Restrictions, and Emergency.

A triggerpoint should correspond to some measure of demand or available supplies. For a public supplier, it should be based on an assessment of the system's ability to meet continuing demand, given deteriorating resources and the potential for serious consequences if demand is not further managed.

The Figure, "Balancing the Water System's Supply and Demand," summarizes those factors which should be considered in establishing a public supplier's triggerpoints. When the system and not the source is at capacity, the triggerpoints must be based on demand. However, where deliverable capacity is limited due to source considerations, appropriate triggerpoints will be based on source factors. Phase activations will include both types. Various indices could be used.

A local water supplier may want to classify emergencies according to situations that demand different levels of response. Suppliers should distinguish between emergencies.

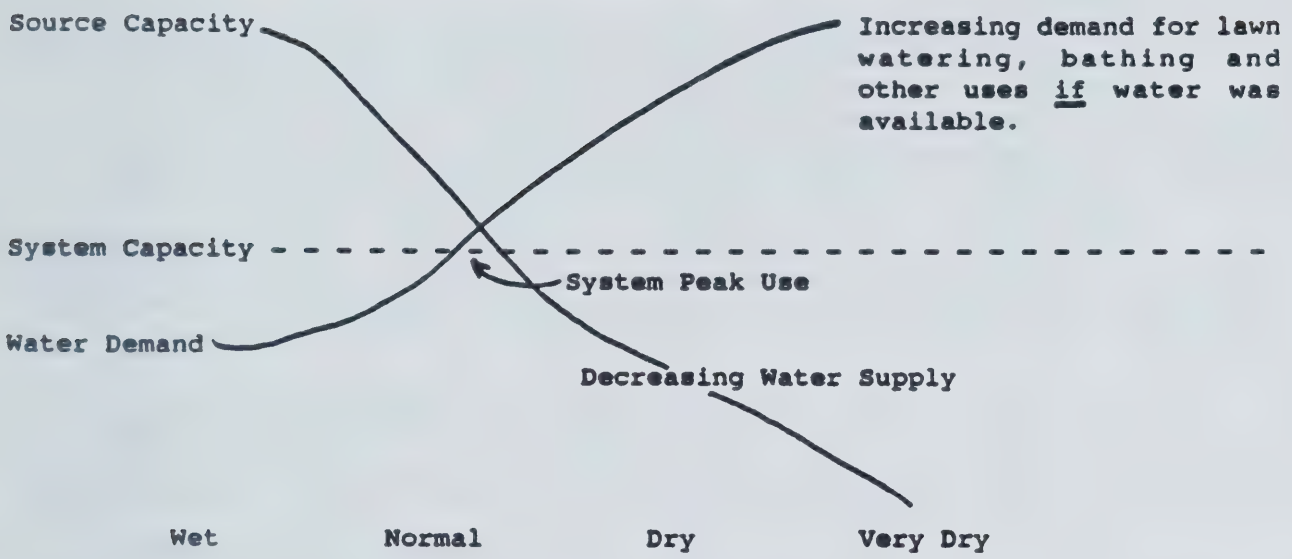
Public water suppliers are urged to develop a classification system to reflect water use priorities. A classification system clarifies issues of fairness, hardship and, ultimately, management effectiveness. Some water uses are important socially or economically. Some water uses are essential and some are non-essential.

These classes may be different from place to place based on differences in use and local priorities. Each water supply system must decide the degree to which they support these general classes under varying situations. These classes are useful in identifying goals, priorities, and strategies, as well as weaknesses of a drought management plan.

A public water supplier's plan should classify water uses, while considering all the water management options available; i.e., pricing, conservation,

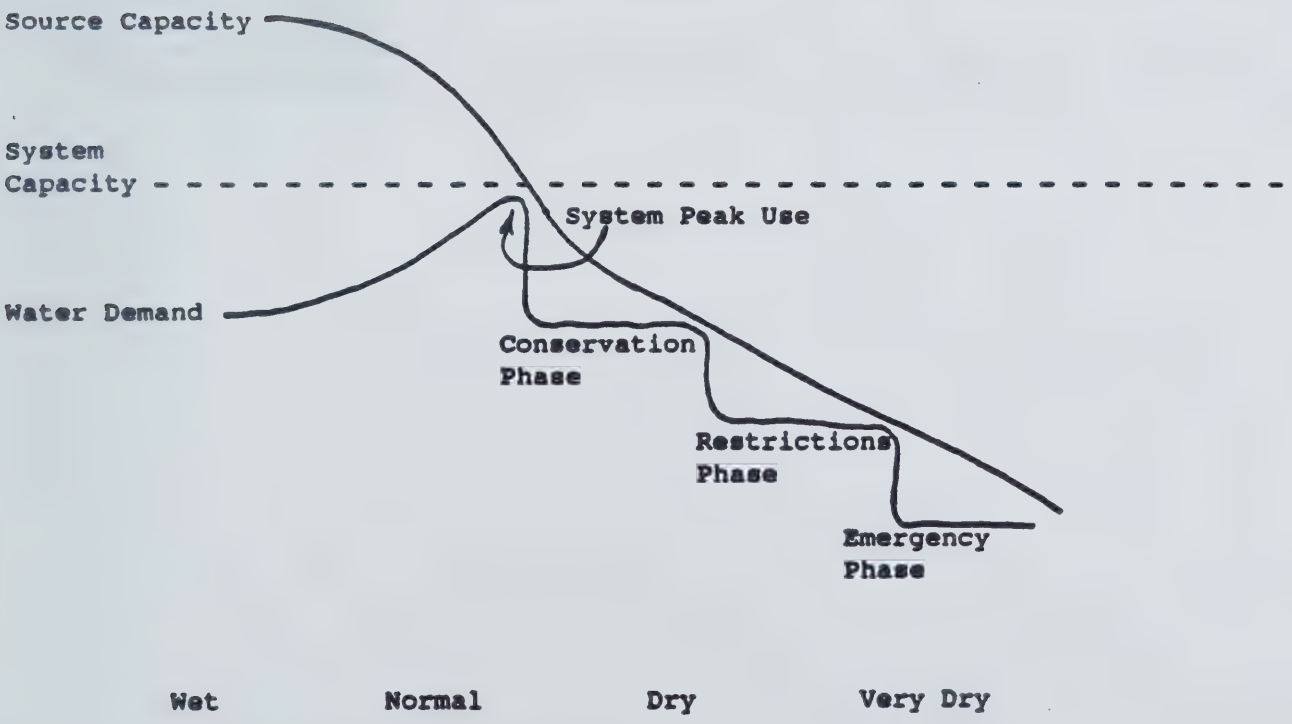
Balancing the Water System's Supply and Demand

A. Unmanaged Water Use



Worsening Drought Conditions

B. Managed Water Use



Worsening Drought Conditions

supplemental supplies, bans, etc. An effective drought management plan would focus on curtailing one class of uses before strong measures are implemented to significantly cut the next higher water use classification. Classifying uses and analyzing their contribution to reducing the demand on the system may reveal a plan weakness.

The uses included in a class may vary by public supplier. One water supply system may only need to ban non-essential water uses and require cutbacks in other uses of water to meet its conservation objective. Another system may need to impose cutbacks only on its non-essential uses. The Figure "Recommended Water Use Classes and Class Restrictions," shows a typical scenario. Defining class restrictions insures consistent policies in the development of an emergency water management plan. To simply pick and choose among responses and policies without regard to potential benefits runs the risk of inadvertently cutting back on a high priority water use or allowing some lower priority use to continue as if there were not a water shortage.

Planning for self-supplied water users including self-supplied industry is similar to public suppliers in that the provision of water is best addressed by the water user. Water sources and uses should be evaluated and measures should be identified which address water quality and water quantity problems.

Where conflicts over water rights and water quality problems emerge or local situations become "emergency" situations, the Department of Health and Environment, the Tennessee Emergency Management Agency and the Governor can enter the situation. Once a situation is declared an emergency, special actions can be taken under the Governor's emergency powers authority.

The figure, "Drought Response," summarizes Tennessee's interim drought management plan.

Future planning will examine more fully a process for dealing with water use conflicts and on details in the development of local water shortage management plans.

Recommended Water Use Classes and Class Restrictions
(Wood and others, 1986)

General Water Use Class	Program Phase		
	Conservation	Restrictions	Emergency
Essential, First Class	Voluntary Cutbacks	Voluntary Cutbacks	Voluntary Cutbacks and/or Restrictions
Essential, Second Class	Voluntary Cutbacks	Voluntary Cutbacks and/or Restrictions	Restrictions and/or Bans
Essential, Third Class	Voluntary Cutbacks	Restrictions and/or Bans	Bans
Non-Essential	Restrictions and/or Bans	Bans	Bans

Drought Responses

Condition and Management Phase*	State and Federal Actions	Local Actions		
		Public Water Suppliers	Industrial	Agricultural, Self-Supplied, Environmental
Normal Conditions Water supply is adequate; water quality is acceptable under normal management	.Develop precipitation, streamflow, ground water, and water quality monitoring programs .Conduct state and regional water studies and coordinate recommended actions .Assist public water suppliers and local government in developing Emergency Water Management plans .Establish public education program	.Develop local drought management plan .Develop additional storage and treatment facilities; evaluate distribution system .Adopt standby rates, other necessary ordinances and codes, and establish mutual aid agreements, interconnections, conservation education, etc.	.Develop local drought management plan .Develop additional wastewater storage .Develop alternative water supplies, water storage and conservation measures .Purchase standby equipment and install permanent equipment as necessary for recycling	.Develop local drought management plan .Evaluate need for irrigation .Enlarge pond, purchase tanks, drill wells, install conservation devices and livestock watering tanks .Evaluate agricultural water use and find where conservation could be used, including use of "drip" irrigation .Evaluate domestic water use and install water-saving devices, etc. to reduce stress on supply source
Drought Alert Lower than normal precipitation, declining streamflows, reservoir levels, and groundwater levels; greater than normal demand	.State issues Drought Alert to media and notifies targeted water users (Alerts may be regional or local) .Intensify selected monitoring activities .State initiates an awareness program	.Monitor water sources and daily water use for specific purposes and anticipate user demand .Monitor potential conflicts and problems	.Monitor water sources and daily water use for specific purposes and anticipate demand .Monitor water quality	.Monitor water sources and daily water use for specific purposes and anticipate demand
Conservation Phase Water supplies/ water quality deteriorating or conflicts among users	.Disseminate water supply and water quality data .Monitor systems and users having past problems and monitor plan implementation .Coordinate state and federal supply and water quality actions .Respond to local and individual appeals for assistance ."Post" streams where water quality standards are not met .Commissioner issues orders to water suppliers and/or dischargers	.Implement "conservation" phase at plan triggering point. Potential conservation measures include curtailment of outside uses, education, and pricing .If conservation goal is not obtained, implement restrictions .Notify Bureau of source conflicts	.Institute recycling, cutback production, store wastewater, alter production schedule per industrial water management plan during a drought .If goals are not met, implement additional measures .Notify Bureau of source conflicts	.If assessed source is capable, irrigate crops .Provide tanks, maintain streamflows, etc., to meet supply needs of livestock, fish, and aquatic life .Continue conservation of domestic supplies .Notify Bureau of source conflicts
Restrictions Phase Continued decline in water supply and/or water quality	.Same responses as in Conservation Phase	.Implement "restrictions" phase at plan triggering point. Restrictions could include banning of some outdoor water uses, per capita quotas, cutbacks to non-residential users .Notify Bureau of source conflicts	.Institute additional cutbacks in production, storage of wastewater, or changes in production schedule, etc., per industrial water management plan .Notify Bureau of source conflicts	.Same responses as in Conservation Phase
Emergency Phase Severe water supply or water quality problems due to very limited resource availability	.Governor responds to critical situations by declaring an emergency .TEMA takes action .Bureau mediates in conflicts of source utilization under emergency powers	.Notify TEMA and request emergency declaration .Provide bottled water and sanitation supplies to users .Make hospitals, firefighting, etc., priority .Initiate hauling of water .Comply with Commissioner's Orders	.Request emergency declaration of Governor .Comply with Commissioner's Orders .Request assistance from local government .Implement hauling water for sanitation, domestic uses	.Local government assistance in obtaintaining water for domestic purposes and in supporting livestock .Implement hauling water, etc.

*Each phase would be marked by some event or percent of water supply deficit (triggerpoint) as defined locally.

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REFERENCES

Agardy, F. J. and A. D. Ray, 1973. Emergency Planning for Water Utility Management. American Water Works Association Manual M19. pp. 44.

Alexander, F. M. and L. A. Keck, L. G. Conn, and S. J. Wentz, 1984. Drought-Related Impacts on Municipal and Major Self-Supplied Industrial Water Withdrawals in Tennessee - Parts A and B. U.S. Geological Survey Water Resources Investigations Report 84-4074. pp. 16 and 398.

East Bay Municipal Utility District, 1985. Urban Water Management Plan. Oakland, California.

Hrezo, M. S. 1987. Managing the Drought in the Southeastern U.S. presented at the ASCE WPRM Division Conference, Kansas City, Missouri. pp. 19.

INTASA, Inc. 1982. Flow Reduction: Developing a Public Information Program. U.S. Environmental Protection Agency, Washington, D.C. pp. 41.

Keck, L. A. 1987. Interim State Drought Management Plan. Tennessee Department of Health and Environment, Office of Water Management. pp. 33.

Keck, L. A. 1988. Local Drought Management Planning Guide For Public Water Suppliers. Tennessee Department of Health and Environment, Office of Water Management. pp. 100 and five appendices.

Matthai, H. F. 1979. Hydrologic and Human Aspects of the 1976-77 Drought. U.S. Geological Survey Professional Paper 1130. U.S. Government Printing Office, Washington, D.C. pp. 84.

New England River Basins Commission, 1980. Before the Well Runs Dry: A Handbook for Designing a Local Water Conservation Plan. Water Conservation Programs Report, Boston, Massachusetts. pp. 95.

New York State Senate Research Service, 1986. The Hidden Supply. New York State Senate, Albany, New York. pp. 142.

Pennsylvania Gas and Water Company, undated. Drought Contingency Plans for Pennsylvania Gas and Water Company's Springbrook and Scranton Division. pp. 11.

Planning and Management Consultant, Ltd., 1980. Submitted to the U.S. Army Engineer Institute for Water Resources. The Evaluation of Water Conservation for Municipal and Industrial Water Supply, Procedures Manual. U.S. Army Engineer Institute of Water Resources, Fort Belvoir, Virginia.

Planning and Management Consultants, Ltd., 1986. Formulation of an Optimal Urban Drought Plan. Planning and Management Consultants, Ltd., Carbondale, Illinois. pp. 35.

Purvis, J. C., Sidlow, S. F., and W. Tyler, eds., 1987. Southeastern Drought Symposium Proceedings. South Carolina State Climatology Office Publication G-30.

Reed, Gregory D., 1982. Drought-related Water Conservation Efforts in Missouri. Journal American Water Works Association, (March 1982). pp. 121-125.

Rouse, R. E., M. W. Perry, J. C. Purvis, and A. W. Zuplan, 1984. South Carolina Drought Response Plan. State of South Carolina Water Resources Commission. pp. 42.

Smith, R. L. and L. K. Lampe, 1982. A Drought Contingency Manual for Kansas Public Water Utilities. Prepared for the Kansas Department of Health and Environment by the Center for Research, Inc., University of Kansas.

South Florida Water Management District, 1986. Water Shortage Plan. South Florida Water Management District, West Palm Beach, Florida. pp. 25.

Texas Water Development Board, 1986. Guidelines for Municipal Water Conservation and Drought Contingency Planning and Program Development. Austin, Texas. pp. 34.

Tompkins, Jack. Guidelines for Emergency Operations Planning for Community Water Systems. To be Printed. Tennessee Department of Health and Environment, Office of Water Management.

Truby, J. and L. Boulas, 1986. The Colorado Drought Response Plan. Division of Disaster Emergency Services. pp. 16.

U.S. Army Corps of Engineers and Bureau of Water Resources Management Commonwealth of Pennsylvania, 1983. The State of the States in Water Supply/Conservation Planning and Management Programs. U.S. Army Corps of Engineers. pp. 17.

U.S. Resources Council, 1980. Water Conservation Planning Guide (Draft). U.S. Water Resources Council, Washington, D.C.

Water and Science Technology Board, National Research Council, 1986. Drought Management and Its Impact on Public Water Systems. National Academy Press, Washington, D.C. pp. 127.

Wentz, S. J., R. M. Baker, and B. Gillett, 1986. Drought-Related Impacts on Water Uses in North Alabama. Geological Survey of Alabama Circular 127B. pp. 483.

Wood, P.A., Lee, V. D., Morgan, D., Denton, V., and Harker, D. F., Jr., 1986. Kentucky Water Shortage Response Plan. Kentucky Natural Resources and Environmental Protection Cabinet, Frankfort, Kentucky. pp. 89.

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MIDWESTERN GOVERNORS' CONFERENCE

A Report to Midwestern Governors

Update: Midwestern States' Response to the Drought

Prepared by:

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Yorktown Office Center
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312/810-0210

August 1988

As drought conditions have worsened throughout the Midwest, states have taken actions both to assist farmers with immediate needs as well as to plan for more general assistance programs for long-term needs.

All twelve Midwestern states have responded by opening drought hot-lines. These toll-free services provide information ranging from hay location, weather information and water levels to information on state and federal aid programs and other financial counseling.

The Midwestern states have followed Indiana's lead and used administrative and judicial channels to pressure insurance companies to make good on drought insurance policies sold in the states.

As of July 28, all or parts of four Midwestern states -- Indiana, Missouri, Ohio and Wisconsin -- had been designated disaster areas. Illinois, Iowa, Michigan, Minnesota, North Dakota and South Dakota had made federal disaster designation requests.

What follows is an update to a mid-June Council of State Governments summary of actions. Information included here is current as of August 5, 1988.

Illinois

* The state's standing Drought Task Force has been convening since early June. This body combines six state agencies -- Division of Water Resources, EPA, State Water Survey, Department of Agriculture, Emergency Services and Disaster Agency, and the Department of Commerce and Community Affairs.

* With ongoing state-wide monitoring, the Task Force keeps track of water levels, conditions and availability at all times.

* Through a linked-deposit program, the state treasurer is making $50 million available to rural banks for low interest loans to farmers to help meet immediate needs. While there are no limits on the amounts of loans, all money must be spent on drought-related expenses. Contact: Larry Quinn, (217) 782-2211.

For more information contact Donald Vonnahme, Director, Division of Water Resources, Department of Transportation, (217) 782-0690.

Indiana

* The state has been declared a disaster area and thus qualifies for federal agriculture disaster funds.

* Indiana has loosened eligibility requirements for its Treasurer's Farm Program and also added $10 million to that program. The state agreed to roll over loans normally due in January. Loans through the program are guaranteed not to be at rates higher than 6.5 percent plus 2.5 percent.

* Indiana's Drought Task Force is considering offering direct food relief to migrant workers in the state. Contact: Jean Merritt, (317) 232-1139.

For more information contact Mark McDermit, Agriculture Ombudsman, (317) 232-8770.

Iowa

* Iowa convened its standing drought work group during the spring. This body includes extension services, Department of Natural Resources, Agriculture Stabilization and Conservation Service (ASCS) and the National Guard.

* A satellite up-link program provides information on Conservation Reserve Program (CRP) land and extension services such as nitrate testing of silage.

* The state is monitoring grain elevator operators and applying for disaster relief that would include Small Business Association loans that could aid operators.

For more information, contact Keith Heffernan, Director, Department of Commerce, (515) 281-7401.

Kansas

* Governor Hayden appointed a drought task force in May. The small working group of federal and state agencies meets weekly to assess the situation and make recommendations to the Governor.

* State extension services have put out warnings about nitrate in silage and accruing pesticides in fields.

* Eleven Kansas counties near the Missouri border have been declared disaster areas.

For more information, contact Colonel Mahlon Weed of the Emergency Preparedness Division, (913) 233-7560.

Michigan

* Michigan has an ongoing water emergency working group comprised of eleven state agencies. They have monitored water levels.

* The state is considering making some existing Economic Development Fund money available to farmers.

* Michigan has intensified standing social service programs to aid migrant workers. The state subsidizes construction of migrant worker housing and has medical programs in place.

* The state provided $500,000 to its extension services to increase testing for nitrates in silage and chemicals in fields. Michigan has also funded a study of water usage for agricultural purposes.

For more information, contact Pat Casey, Advisor to Governor Blanchard, (517) 373-3427.

Minnesota

* Minnesota has two standing task forces addressing drought concerns. The Governor's Drought Task Force, comprised of agriculture agencies like ASCS and FmHA, Department of Natural Resources, extension services, the National Weather Service and crop agencies, monitors water issues. The Agriculture Task Force, comprised of farm organizations, state agency officials, farmers and rural businesses, monitors agriculture issues and recommends state policy responses.

* Minnesota has a hay exchange program under the auspices of the Attorney General, extension services and the Department of Agriculture.

* The state allocated $100,000 to help communities with water shortages and $100,000 to a hay transportation program.

* To address an extensive problem with migrant workers, the state jobs and training program has allocated funds for housing for unemployed migrants.

* Minnesota has a mediation and farm advocate program to mediate disputes between farmers and lenders. The state also has a farmer to farmer crisis counseling program, set up in 1984, to provide counseling on financial, production and other problems that will be exacerbated by the drought.

For more information, contact Pat Motherway of the Department of Agriculture, (612) 297-1551.

Missouri

* Missouri convened a special legislative session to discuss the drought.

* The Governor increased the MoBucks state fund by $100 million. The program, in place since 1986, provides low interest loans for farmers and small businesses.

* The Department of Natural Resources and the Department of Economic Development administer a special $700,000 fund for hard hit water supply districts.

* The Department of Natural Resources is working with communities trying to conserve water. DNR has helped write model ordinances for mandatory conservation.

* The state is closely monitoring livestock water supplies.

* The university extension program is publicizing the problems of nitrate in silage and chemicals in fields. Counties provide testing kits.

For more information, contact Randy Sissel, Press Secretary to Governor Ashcroft, (314) 751-3222.

Nebraska

* Nebraska has been among the least hard hit of the Midwestern states. With extensive irrigation and more than normal rainfall in most of the western half of the state, Nebraska agriculture is emerging from the drought in good shape according to the State Department of Agriculture.

* Nebraska has a standing Drought Assessment Resource Team. Comprised of officials from local, state and federal agencies and university officials, the task force monitors the situation and makes recommendations to the Governor.

For more information, contact Theresa Klein, Public Information Officer of the Department of Agriculture, (402) 471-2341.

North Dakota

* North Dakota has a comprehensive farm loan program in place that may be adjusted in response to the drought. Loans can be made for real estate, new farmer start-ups and interest buy-downs.

* The state has a drought contingency plan that was triggered in May by executive order. Agriculture and water resource officials meet with the Governor. They monitor conditions, gather and disseminate information and coordinate state responses.

* Disaster unemployment assistance studies revealed that state wide demand for migrant workers has actually increased during the drought.

* The Governor met with Agribusiness leaders in late July to keep them posted on state projects and to get their input. He also met with lenders, urging them to use caution in loan decisions.

* The state released game and fish lands for haying, has allowed haying on highway right of ways and has modified trucking regulations including waiving permit requirements and allowing larger loads in order to facilitate hay hauling.

For more information, contact Jeff Weispfenning of Governor Sinner's office, (701) 224-2200.

Ohio

* Ohio formed a drought task force in mid-June.

* The state is using both its Rainy Day Fund and temporary budget overrun to provide emergency funds for individual and community drought-related expenses.

* The state is considering subsidizing extensions of its nitrate and chemical residue testing programs.

* Ohio farmers have urged the state to monitor grain elevator operators and food processors. Ohio has a grain handlers indemnity fund.

For more information, contact Delores Parker of Governor Celeste's office, (614) 466-2972; or Tony Core of Senator Cupp's office, (614) 466-7584.

South Dakota

* In March, anticipating a dry spring, the South Dakota Department of Agriculture instituted its low interest loan program aimed at replenishing livestock herds.

* The state has a standing drought task force comprised of agriculture, water, emergency preparedness, health and social service officials. They monitor weather, water and well conditions and other drought effects, serve as an information clearinghouse, work with counties on disaster requests and make recommendations to the Governor.

* Under a plan now awaiting federal approval, the state would make Conservation Reserve Program payments to farmers in an up-front lump sum instead of spreading them out over ten years. Federal payments would then go to the state.

* Governor Mickelson directed the Department of Social Services to apply for a $300,000 grant for regional mental health clinics so rural people have access to mental health services. Under the program, bankers, extension workers, clergy and others in frequent contact with farmers would be trained to recognize symptoms of depression and would be equipped to provide information on mental health services.

* The Governor presented legislation to create an Agriculture Mediation Program to mediate farm foreclosures.

For more information, contact Gretchen Lord-Anderson of Governor Mickelson's Office, (605) 773-3661.

Wisconsin

* Following the Governor's initiative, the Wisconsin legislature put $35 million into low interest loans to troubled farmers who can't meet lender's minimum standards. These supplemental loans cover agricultural production and drought assistance activities.

* In the same special session, the state legislature enacted a one-time 10 percent credit on property taxes up to $1,000 for all full-time farmers in the state. The credit will occur only if the state crop-loss exceeds 40 percent.

* Wisconsin established an inter-agency task force of agriculture, natural resources and rural social service officials to monitor the situation, assess damages and serve as information brokers.

For more information, contact Don Bezruki of the Legislative Audit Bureau, (608) 267-7873.

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STATE GOVERNMENT RESPONSE TO THE 1987-88 DROUGHT

IN WASHINGTON STATE

Presented by Jim Bucknell*

INTRODUCTION

Like many parts of the nation, Washington State has been experiencing a drought for nearly two years. In spite of our reputation as a water rich state and our nickname of "The Evergreen State", we do, in fact, experience water shortages from time to time just like everyone else. In fact, portions of eastern Washington receive less than 4 inches of rainfall even in normal water years.

In any discussion of droughts and the activities undertaken to relieve their impacts, it is important to realize that this is by no means a unique event. Droughts are a naturally occurring phenomenon that have occurred many times in the past and should be expected to occur in the future. What varies is the duration of the droughts, the areas affected, and the severity of their impacts. The last major drought in Washington State occurred in 1976-77.

It is also important to recognize that drought impacts cause many problems which cannot be resolved. However, there are also a number of problems and issues which can be dealt with if the proper planning and implementation mechanisms are in place. This notion that proper planning and implementation mechanisms can make a difference was key to the development of the state of Washington's drought response during the recent drought.

BACKGROUND

In order to understand how the state's response developed over time, it is important to briefly examine some of the conditions and events that have occurred over the past eighteen months.

The winter of 1986-87 provided near normal water supplies in many areas of the state.

Although there were concerns about water supplies in the first part of 1987 because of low snowpack and cumulative precipitation levels, no serious impacts were observed.

As the summer progressed, very little precipitation was received. As a result, streamflows for the normally low runoff months of July-September 1987 were significantly below their norms. In many cases, these flows were the lowest flows on record and were well below those encountered during the 1976-77 drought, a period where many new low streamflow records were set.

*Jim Bucknell is the Supervisor of the Water Resources Policy and Management Section of the Washington State Department of Ecology.

The continuing water supply problems and related concerns resulted in the formation of the Water Supply Availability Committee (WSAC) by the Department of Ecology in August of 1987. The purpose of this committee is to collect, evaluate, and assess water availability data, identify areas of water shortage, assess the actual and expected impacts of shortages, examine short- and long-term forecasts of water supply conditions, and report findings to the Ad Hoc Executive Water Emergency Committee (EWEC). Both the WSAC and the EWEC are discussed in more detail below.

October is generally the month where the Pacific Northwest begins to receive its fall rains and streamflows generally increase significantly. However, the rains did not occur and streamflows for the month of October 1987 remained at levels far below the historic monthly norms. For example, in western Washington, streamflows averaged about 22 percent of normal for the month of October. In eastern Washington, the flows averaged about 50 percent of normal for the month.

The fact that streamflows remained so low was an indication of a serious water supply shortfall. This shortage created a great deal of concern for water supplies throughout the state, including the City of Seattle and the Yakima Irrigation Project of the U.S. Bureau of Reclamation.

Statewide, the state received only about 5 percent of normal precipitation for the month of October.

Conditions remained well below normal through February, 1988 when the state received four months of above normal precipitation. The months of March through June were above normal with July and August once again below normal. At the present time, we are not experiencing any serious drought-related impacts in Washington State but we are still concerned about water supplies for 1989. The Yakima Irrigation Project will end the 1988 irrigation season with only about one-fifth of their normal carryover storage. This project normally stores about 40 percent of its total water supply so they will be even more dependent than normal on winter precipitation to ensure a good water supply next year.

STATE DROUGHT RESPONSE

As mentioned previously, the Department of Ecology formed the Water Supply Availability Committee because of increasing concerns with the water supplies in the fall of 1987. The WSAC consists of representatives of several state, federal, and local agencies, including the U.S. Bureau of Reclamation, the U.S. Geological Survey, the National Weather Service, the Soil Conservation Service, and the City of Seattle. Ecology chairs this committee which has met monthly since it was established.

The WSAC has prepared water supply update reports which are distributed to the Governor's Executive Water Emergency Committee (discussed below), the Governor's Office, the Legislature, other agencies, the media, and members of the public. These reports provide information on water supply conditions including precipitation, streamflow, and snowpack data, as well as examining the forecasts for weather and streamflow runoff. In our view, the WSAC has been very valuable during the last year or so. First, it provides an

effective mechanism for the coordination of state, federal, and local water supply forecasts and monitoring activities. Secondly, it has provided an excellent focal point for the media to have access to information on the state's water supply conditions.

Because of continuing water supply problems, an Ad Hoc Executive Water Emergency Committee (EWEC) was formed by Governor Booth Gardner in the fall of 1987 to identify and address the problems created by the drought and to establish policies which would ensure a coordinated response by the state government to these problems. The Department of Ecology is the lead agency for this Committee which consists of the directors of the state departments of: Ecology, Community Development, Social and Health Services, Energy Office, Natural Resources, Trade and Economic Development, Agriculture, Fisheries, Wildlife, and Employment Security as well as representatives of Cooperative Extension, the U.S. Bureau of Reclamation, and the U.S. Army Corps of Engineers. The purpose of this Committee is to coordinate the state's drought response.

The Committee established several state level task forces to:

1) examine drought impacts on particular activities;

2) identify impacts expected if the drought continues; and,

3) to recommend ways to deal with the drought impacts.

Some of the areas specifically examined by the task forces are: agriculture, forest and wild fire control, fish and wildlife, domestic and municipal supply, economic and industrial activities, employment and community impacts, and the need for public information and education.

In early March, the Committee prepared a report entitled Initial Drought Action Program for 1988. This report was submitted to the Governor and announced at his press conference on March 15. The goals of the action program are to:

(1) Effectively monitor the drought conditions;

(2) Initiate actions to conserve water early in the drought to help alleviate water supply shortages that might occur later;

(3) Provide assistance to mitigate some of the economic losses;
(4) Prepare for shortages through planning and development of alternative water supplies where possible; and

(5) Coordinate the actions of the state with those of federal and local governments.

This Action Program includes a section on each of the subject areas addressed by the task forces. In each area, the report identifies drought-related problems which were either being experienced or which were anticipated if the drought continued. For each of these problems, short- and long-term actions were identified which would help to reach solutions to

the problems. In this way, the Program clearly identified the problems that would likely occur and the actions that each agency needed to take if drought conditions persisted. Although weather conditions allowed us to relax and not pursue all of the program elements, a number of the actions identified in the Program have been carried out and the Program continues to serve as a valuable reference tool for future droughts and will be used as a basis for portions of the drought contingency plan which we are currently developing.

Because of concerns with water supplies for 1988, the Legislature passed SSSB 6513, the drought emergency bill. This bill was initiated as agency request legislation by the Department of Ecology. This bill enables the state to respond effectively to expected drought conditions. It extends the provisions of a similar 1987 drought bill including the availability of approximately four million dollars in drought alleviation funds to April 30, 1989. It expands the uses to which funds may be applied to include fisheries (up to 10 percent of available funds). It allows Ecology to provide grants for 20 percent of the project costs (formerly 15 percent) except that for projects where 50 percent or less of normal water supplies are anticipated, Ecology may provide grants for 40 percent of the total project costs. It also allows Ecology to issue emergency water use permits with a minimum of delay. The bill provides resources for staffing by Ecology to plan and administer drought relief activities including the development of a state drought contingency plan for responding to future drought conditions.

The bill included an emergency clause so that it took effect immediately and was intended to provide much needed and timely relief to agriculture and fisheries, two uses that tend to be heavily impacted by drought conditions.

SUMMARY

In spite of recent rains which have helped alleviate drought conditions across the state, the drought is not over. There are still areas where water supply problems are being experienced (or are expected). The entire state remains below normal in precipitation for the water year to date and, although several of the last few months have been above normal in precipitation, there continues to be serious concern with ground water conditions and the potential for lower than normal streamflows during the summer and fall of 1988. Of course, if the winter of 1988-89 is drier than normal, then the state may again be facing serious water supply problems (including potential energy production problems) in 1989.

If conditions do not improve, the state will undoubtedly continue to use both the Water Supply Availability Committee and the Executive Water Emergency Committee as means to ensure coordination of the drought monitoring and relief efforts. Similarly, we will probably reconvene the task forces which were formed in 1988 to develop a drought action plan for 1989 if such an effort is needed.

Thank you for your attention. I'd be happy to answer any questions.

THE 1986-88 DROUGHT IN WESTERN NEVADA - DROUGHT PLANNING AND MITIGATION

John W. James
Nevada State Climatologist
Chair of Governor Richard Bryan's Drought Task Force
Associate Professor of Geography, University of Nevada-Reno

Background

Due to the increasing concern about water supply and the potential drought in Summer and Fall 1988, in the Tahoe-Truckee, Carson and Walker River drainage basins along the eastern slopes of the Sierra Nevada in western Nevada, Governor Richard Bryan appointed a ten man Drought Review and Reporting Committee in February 1988. It was noted by the Governor that the original ten person committee would be expanded if water supply conditions in other areas worsened as the 1987-88 Water Year (October 1-September 31) progressed. Such was the case in March as portions of the Humboldt watershed of northern Nevada reached drought proportions, so an eleventh member was added.

The Committee was charged with assessing water availability and to make recommendations to the Governor and others for necessary action to address this concern of water shortages. The Committee was also asked to call on representatives of various local state and federal agencies for information or data necessary in correlating recommendations.

The Committee met several times at various locations in the drought effected areas. Each meeting was open to public participation, with a special evening meeting held in Reno in May.

A similar committee was appointed by California Governor Deukmejian. One representative from each state was assigned to attend the other state's meetings. John James, State Climatologist and Chair of the Nevada group was chosen to represent Nevada at the California meetings.

As of October 15, western Nevada remains firmly in the grip of a severe drought. The 1988 Water Year was the sixth driest in 118 years of record at Reno and the driest in 40 years. The June-September period was also the warmest of record. Near record evaporation accompanied all this.

Lake Tahoe stopped flowing into the Truckee River on October 10, thus reducing the river to a trickle. Last ditch Truckee River storage water in Donner and Independence Lakes was tapped beginning October 1. Little used urban wells in Reno were activated in October. Outflow from Lahontan Reservoir along the Carson River ceased the end of August, with the reservoir reduced to a puddle.

Along the Walker River there was no natural water flow for users after August 1. Both Topaz and Bridgeport Reservoirs were empty August 15. The Lower Humboldt River Drainage Basin has a similar scenario. There was no

water left in Rye Patch Reservoir for irrigation users this fall.

There have been some very positive actions and responses by local governmental entities and other interest groups. Some of the more important and positive actions are as follows:

A. The Walker River Irrigation District with the approval of the State Engineer has initiated a water pooling pilot program of both underground and surface waters. This program is designed to mitigate the economic impacts that the drought is having on the agricultural water users within the Walker River Irrigation District, and also to provide additional data and information to more precisely define the groundwater system in both Smith and Mason Valleys. The Walker River Irrigation District, State Engineer's Office and the U.S. Geological Survey are working closely in monitoring water use under this pooled effort. There has been an estimated $17 million loss by farmers this year in these areas due to the drought.

B. As a result of recommendations of the Drought Committee, Governor Bryan, on May 12, 1988, forwarded a letter to the Secretary of Agriculture requesting information on the criteria and procedures to be followed in implementing any relief to the agricultural industry that might be available through the Federal programs.

C. On April 28, 1988, Governor Bryan directed all state agencies to comply with all local water conservation measures immediately. As an example, in the case of the Capitol Complex, compliance is required with the odd/even watering days imposed by Carson City. The Governor further indicated that all state agencies are directed to immediately adopt stronger measures or guidelines if the necessity arises. Once a week watering was instituted in August.

D. Initial meetings have been held between appropriate California and Nevada authorities regarding the criteria and procedures to initiate pumping from Lake Tahoe for domestic and sanitary purposes, should the need arise.

E. Action has been taken by local governmental agencies in the Truckee Meadows area and Carson City to clearly define the levels of drought severity which will range from a Stage 1, drought warning, to a Stage 4, critical water shortage. Reno/Sparks and Carson City have been in Stage 3 of water conservation since August 1. Only once a week outside watering is allowed. Steps have been taken by the local entities to encourage public awareness of the water supply situation and to further encourage voluntary conservation. Plans have also been developed whereby local government will initiate emergency measures to curtail water use when the need arises. Westpac Utilities and Carson City are utilizing "water cops" to inform users of wasteful practices and violations. Carson City had initiated the C-scape program which specifically provides criteria and procedures to evaluate the effectiveness of drought resistance landscape to help reduce maintenance and use water more efficiently and effectively. C-scape is achieved by matching irrigation to the water requirements of the plant in balance with environment, and the enhancement of outdoor living.

Westpac Utilities has been encouraging water conservation for a number of years. Westpac, this year, has increased its public awareness program which includes brochures on their Yard Fitness Plan.

F. The media coverage of the drought situation has been good and this should be acknowledged. On a daily basis they have provided the public with accurate data and information concerning, as an example, the level of the reservoirs and the status of available supplies. They are also publicizing the daily water use totals for the 50,000 Reno-Sparks water use customers served by Westpac Utilities. Various radio and television stations have been giving water saving tips and supplying devices to be used to reduce water usage in the home. Additionally, Carson City in cooperation with the U.S. Geological Survey has been publicizing certain hydrologic information regarding ground water levels and other water availability data in Eagle Valley.

G. The farmers in several of the irrigation districts in western nevada, early in the irrigation season, voluntarily decided to leave significant portions of irrigated lands fallow this year in full realization that water supplies would be very limited. Less water consuming crops have been planted in several instances to help in reducing overall water demand. The Walker river Irrigation District cleaned and rehabilitated several of their wells that they had not used for a number of years in order to supplement the limited surface water availability.

H. The State Engineer's office is expediting the processing of new applications to the extent possible and have put additional personnel in the field to provide assistance to water users, monitor pumpage, detect and prevent wasteful and illegal uses.

I. Millions of dollars have been lost by the recreation industry due to low lake and river levels. Fish have died, waterfowl have died or been misplaced, etc.

Water Conditions

Except for extremely heavy record-setting precipitation in Western Nevada associated with the Storm of Record in mid February 1986, climatic conditions in that region of the State have been one of well below normal precipitation for the past three years. Carryover water from the February 1986 wet episode was used to ease water shortages during the dry 1986-87 Water Year. However, much of this was exhausted as yet another dry winter plagued the area in 1987-88, setting up summer and fall 1988 for the worst drought conditions in at least 11 years, possibly since the infamous drought of the early 1930's.

During the most productive portion of the Water Year (November-March) all months had below normal precipitation. Conditions worsened in early 1988, as February and March were the driest such months in the 118 year Reno climate record, and the record for the longest mid-winter dry period was tied in Reno between February 19 and April 12, when 44 days passed with no measurable precipitation. This had been preceded by a similar 40 day period from January 19-February 26. The outcome of the unusual dryness in

Western Nevada during the normally wettest period of the year, was less than 50% of normal precipitation in the east slope Sierra Nevada watersheds by the end of February, and between 40-50% of normal by the end of March. April was somewhat better with 75-100% of normal precipitation, but because precipitation this month is normally much less than during winter months, conditions worsened. May and June also brought below normal conditions, so the dye was cast with precipitation, snow pack runoff, and water in storage facilities all much less than 50% of normal. July, August and September were also drier than normal. Because the climate regime in Western Nevada is one of generally dry summers and winters, the first possibility of any break in the drought will be late fall 1988. Even then, the 1988-89 winter will need to produce above normal precipitation in order to partially replenish ground and surface water supplies diminished by 2-3 years of dryness.

While the West suffered with near record dryness, low snowpack and streamflow on the Tahoe-Truckee, Carson and Walker Rivers, portions of the Humboldt River drainage were less than 75% of normal, with not so severe drought conditions, but nevertheless a problem. However, the remainder of the Silver State had a wetter than normal Water Year 1987-88, with portions of the Central and Southern regions of Nevada enjoying 1 1/2 - 1 3/4 times normal precipitation, as well as above normal mountain snowpack and streamflow.

Recommendations for Drought Mitigation - encompassed in the Drought Committee's 80 page report to Governor Bryan in August 1988.

It should be emphasized that local and private initiatives are primarily responsible for reducing the effects of drought. The role of the state is generally limited to providing the best water supply information available and coordinating intergovernmental activities.

The bottom line through the following recommendations is that water savings should go into a "reserve pool" to be used during dry years. Also, except where specific geographic locations are noted, these are Statewide recommendations.

1. Priorities need to be established for uses of water during droughts. This should be done by local governments.

2. Public awareness about good year-round water conservation practices should be increased, with education programs for schools, through the use of handouts, brochures and mailings, public information meetings, regular contact with the news media and lectures, etc. We recommend that this be done by the various public entities involved.

3. We encourage an inter-state allocation settlement and joint management for inter-state ground water basins. Present disputes should be quickly resolved.

4. New storage facilities should be build where appropriate and feasible, and present storage facilities should be enlarged where necessary.

5. There should continue to be evaluations of the feasibility of water

importation from nearby sources.

6. Xerophytic landscaping should be used in place of lawns in non-residential areas, and all residents should be encouraged to use more drought resistant plants in their yards and water saving devices on their plumbing. Local governments should be requested to review current ordinances regarding plumbing codes and landscape requirements.

7. Winter-time orographic operational weather modification should continue in the Sierra Nevada, and be on an "as needed" basis in other watershed areas. Monies for research and development should not be included.

8. In order to make for a more homogeneous system of water allocation, consolidated water districts should be put in place of present fragmented districts.

9. During drought periods, the State Engineer should be able to allow temporary ground water pumping to alleviate dust control for mining, construction and development activities.

10. The next session of the Nevada Legislature should consider the issue of the prohibition of water meters in applicable areas of the State.

11. The Board on Financing Water Projects created by AB 251, should continue to support the financing of water projects and the development of water for Nevada. The State Department of Natural Resources and Conservation should administer this board.

12. We encourage good year-round water conservation practices, by all Nevadans, whether it be in the home, on the farm or in industry.

ALABAMA RESPONSE TO DROUGHT

by

-- James C. Warman, Acting Director, Water Resources Research Institute, Auburn University, Auburn, Alabama;
-- Dennis H. Block, Assistant Director, Water Resources Research Institute, Auburn University, Auburn, Alabama; and
-- Walter B. Stevenson, Jr., Chief, Natural Resources Development Section, Alabama Department of Economic and Community Affairs, Montgomery, Alabama.

PAPER #28 presented at the Drought Water Management Workshop, November 1 and 2, 1988, at the National Science Foundation, Washington, D.C.

The concluding remarks from the National Research Council's Colloquium on Drought Management and Its Impact on Public Water Systems (September 5, 1985) offer sage advice: "The best way to adjust to drought conditions is to plan adequately in advance." We had not done that in Alabama when the 1986 drought hit nor had we done much better when hit again by the 1988 drought.

A notable exception is the Appalachicola-Chattahoochee-Flint Basin Drought Committee, which was developed in 1986 by the states of Alabama, Florida, and Georgia and the U.S. Army Corps of Engineers. This continuing activity has proven very helpful in responding to drought in that basin, although in a reactionary basis. As a result, the Basin has achieved a four to six month lead in recognizing and planning for an impending drought.

In the late spring of 1988 some Alabama streambeds were dry that had maintained a flow throughout the 1986 drought. Normal seasonal declines of the water table ordinarily begin in July, but in 1988 the declines began in the spring. Agencies with major water programs were receiving four times the number of telephone requests for water information as in a normal year. Farmers were facing decreased yields and abandonment of some fields where they could see no benefit from continued input of tilling, planting and fertilizer. Although it is still too early to predict the economic loss to the agricultural economy, we recall the impacts of the 1980 drought: $200 million direct loss to farmers and $700 million in total loss, considering the loss of the multiplier effect.

Other costs, such as increased transportation costs due to diversion from navigable waterways to more costly modes, have

not been determined. Neither have the economic costs been identified of lost wages where commercial navigation was virtually shut down nor the lost primary and secondary benefits of water based recreation.

Governor Guy Hunt issued Executive Order Number 13 on June 14, 1988, establishing the Governor's Drought Task Force and named Dr. Don C. Hines, Chief of Planning and Economic Development, Alabama Department of Economic and Community Affairs, as chairman. The draft interim report of the Governor's Drought Task Force is attached to provide details about the many activities that have been accomplished and that are planned to meet the purposes stated by Governor Hunt.

The Tennessee Valley Authority (TVA) created a Drought Committee in the summer of 1988. Members included representatives from TVA, the U.S. Geological Survey, the U.S. Army Corps of Engineers and the states of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, and Virginia.

In 1986, the Alabama legislature adopted Senate Joint Resolution Number 172, which established the Alabama Environmental Planning Council (AEPC). The resolution directed the AEPC to "develop a long range environmental plan" for the State of Alabama. The Council completed a draft in October 1988 and has scheduled public meetings in November at six locations throughout the State to hear citizen's comments. The draft report recognizes areas where heavy demands coupled with limited supplies and drought are posing serious problems. During the severe droughts of 1986 and 1988, serious water availability issues were addressed by voluntary allocations and hastily adopted codes in many towns and cities. The Council recommends development of a strategy for drought management and a drought management information system in consultation with public and private water users.

It is our hope and expectation that the effects of the work of the Governor's Drought Task Force and the Alabama Environmental Planning Council, combined with the work of others, will move Alabama into a strong position based on advanced planning for management of our water resources when the next drought hits.

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INTERIM REPORT

GOVERNOR'S DROUGHT TASK FORCE

BACKGROUND

On June 14, 1988, Governor Guy Hunt issued Executive Order No. 23 which created the Governor's Drought Task Force and listed those agencies which would compose the task force. Those agencies are:

1. Alabama Department of Economic and Community Affairs
2. Alabama Emergency Management Agency
3. Alabama Department of Environmental Management
4. Alabama Department of Conservation and Natural Resources
5. Alabama Development Office
6. Alabama National Guard
7. Alabama Department of Agriculture and Industries
8. Alabama Forestry Commission
9. Geological Survey of Alabama
10. Alabama Department of Public Health
11. Alabama Power Company
12. U. S. Corps of Engineers (Mobile District)
13. Tennessee Valley Authority
14. U. S. Department of Agriculture, Agricultural Stabilization and Conservation Service
15. U. S. Department of Agriculture, Farmers Home Administration

As stated in Executive Order No. 23, the purpose of the Task Force is to:

"1. Monitor progress and effects of drought and secure projections of expected future conditions.

2. Analyze drought information and formulate coordinated plans and recommendations designed to mitigate adverse impacts.

3. Coordinate communications among state and federal agencies whose activities and responsibilities impact those sectors affected by the drought (small business, agricultural, navigational, industrial, and municipal interests).

4. Make recommendations to the Governor regarding both short-term and long-term actions available to mitigate drought effects.

5. Coordinate efforts to be prepared to promptly respond to forest fire emergencies which may result from drought conditions.

6. Serve as a clearinghouse for available information and respond to requests from the public and private sectors for information, recommendations and assistance."

TASK FORCE MEETING - JUNE 20, 1988

The initial meeting was held in Montgomery on June 20, 1988. Dr. Don C. Hines, Chairman of the Task Force, stated that the objective of the meeting was to assess the severity of the drought in Alabama and the range of drought related problems. Representatives of the 15 member agencies presented brief reports concerning the status and impact of the current drought situation as it pertained to their agency.

As of June 20, 1988, agencies reported that 75% of groundwater wells were below normal levels based on fall (1987) and spring (1988) measurements. Surface water as defined through stream flow is currently indicating deficits running below those of the drought of 1954 (the previous drought of record). Levels of most of the major storage reservoirs are below normal pools. Lake Martin, on the Tallapoosa River, which has the bulk of the storage in the Coosa-Tallapoosa basins, did not fill this year and could be down 19 feet at the end of October, 1988 based on continued reduced rainfall and low stream flow (based on Alabama Power Company projections). Alabama Power Company stated that average rainfall through October will not appreciably effect lake levels. Substantial rainfall during late fall and winter will be necessary to fill the reservoirs. Reports on navigable waterways in Alabama indicate reduced river depths on the Alabama and Appalachicola - Chattahoochee - Flint (AFC) Rivers systems. By June 20, 1988 commercial operators on these navigable systems have resorted to reduced tonnage on the Alabama River and almost ceased commercial traffic on the ACF. To date, no major water quality problems have been detected as a result of the drought. In addition, no significant fish kills have been reported, however, they were expected. Some concern exists regarding potential health hazards (disease vectors, water quality problems) but no problems have resulted to date.

The agricultural sector reported that serious crop losses and livestock feed losses may result if the drought condition continued. The U. S. Department of Agriculture has approved haying and grazing on Acreage Conservation Reserve (ACR) and Conservation Use (CU) set aside land. Fifty-five counties have requested haying/grazing authority. The U. S. Department of Agriculture has also approved haying on Conservation Reserve Program (CRP) areas. In addition, there is an emergency feed program for which 90% of the counties are expected to qualify. Agriculture reports that hay is rated a disaster. In addition, corn, cotton, peanuts and soybeans are expected to record low yields.

Dry conditions have caused a considerable increase in the number of forest fires in Alabama which was made especially bad due to the low soil moisture and stressed condition of trees and

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brush. In addition, the Alabama Emergency Management and the Alabama National Guard are hauling water in six counties. Most problems in domestic systems are due to heavy demand for water or malfunction of equipment - lack of source has not been a problem in most situations.

The first Task Force meeting concluded that: 1.) the State of Alabama is currently in the midst of both an agricultural and a hydrological drought; 2.) normal rainfall throughout the remainder of the summer and the early fall might alleviate the agricultural drought, however, it would have little effect on the hydrological drought; 3.) timely monitoring of meteorological and hydrological data would assist Task Force agencies in assessing and responding to drought impacts as they develop; and 4.) due to the magnitude of impacts resulting from the drought, subcommittees were needed to address various specific areas of concern.

The following recommendations/actions were developed by the Task Force and released to the press:

1. A clearinghouse will be established in ADECA for individuals to report drought related problems and to obtain data on drought conditions.

2. The ADECA/ADO system of regional representatives will serve as local contact persons to monitor drought conditions in each region of the state and to serve as a local conduit for information relating to drought problems which will be coordinated with local emergency management agencies.

3. The ADECA will produce a weekly report of drought conditions in the state that will summarize the various facets of the problem.

4. A system of public meetings will be scheduled in different areas of the state beginning the week of June 27th.

To date, all of these recommendations have been implemented. A summary of these activities follow.

Approximately 125 telephone calls have been received through the clearinghouse on drought related problems. ADECA is continuing to maintain this service.

Eleven weekly summary data sheets have been compiled and distributed. Starting with issue number 9 the summary sheets were changed from weekly to bi-weekly. The data sheets consist of information including rainfall summary; reservoir levels; surface water conditions; groundwater conditions; status of commercial navigation; agricultural conditions & relief programs; and the drought related emergency responses activities of the Alabama Emergency Management Agency and the Alabama National Guard.

In addition, the Alabama Emergency Management Agency (AEMA) is issuing weekly county summary sheets of drought related information/problems. These summary sheets consist of county emergency managers' survey of county conditions. AEMA has compiled recommended measures for the general public to assist in water conservation throughout the state.

The Alabama Department of Environmental Management has issued advisories to industrial and public water systems in an effort to minimize any water quality problems which might result from the drought.

The Alabama Department of Agriculture and Industries has established a "Hay Hotline" to help persons needing hay and other livestock feeds. This program assists those persons in need of hay and other livestock feeds to get in contact with those persons with supplies of the products.

At the request of the Governor's Drought Task Force, the Federal Emergency Response Board met on July 1, 1988 and recommended to the Governor that he request a disaster declaration from the Secretary of Agriculture. On July 19, 1988, the Secretary of Agriculture declared all 67 Alabama counties natural disaster areas due to events occurring during the period April 1, 1988 through July 1, 1988.

As recommended by the Governor's Drought Task Force, public meetings were held throughout the state. Meetings were held at the following locations and dates:

Alexander City	7:00 P.M.	June 29, 1988
Gadsden	1:30 P.M.	July 6, 1988
Decatur	7:00 P.M.	July 6, 1988
Tuscaloosa	10:00 A.M.	July 12, 1988
Selma	3:00 P.M.	July 12, 1988
Eufaula	10:00 A.M.	July 13, 1988
Dothan	3:00 P.M.	July 13, 1988
Mobile	7:00 P.M.	July 15, 1988

The purpose of these meetings was two-fold - to provide an opportunity for the Task Force to present basic data on drought conditions to the public and to provide an opportunity for the public to express their concerns and views on issues related to the drought. The meetings were moderated by Dr. Don C. Hines, Chairman of the Governor's Drought Task Force, or his representative. Each meeting included a short presentation by selected representatives of the Task Force representing surface water,groundwater, agriculture, water quality and emergency response. In addition, most agencies on the Task Force had representatives at all of the public meetings.

Public response to the meetings ranged from light to heavy with attendance ranging from 10 to 80 attendees. Representatives from the news media were present at all meetings and most meetings received wide press and television coverage.

Questions and issues raised by members of the public included: 1.) the impact of low reservoir levels on the recreation industry; 2.) the need to mark navigation hazards in reservoirs with low levels; 3.) the validity of using historical rainfall data to determine operating guidelines for reservoirs; 4.) types of aid available to farmers, particularly crop farmers; 5.) problems with ground water supply; 6.) feasibility of extending public water lines into sparsely settled rural areas; 7.) availability of programs (or lack of) to aid industries with water supply problems; and 8.) current laws governing water resource planning and use and water policy in Alabama.

The public meetings at Eufaula and Dothan were held jointly with the Apalachicola - Chattahoochee - Flint Drought Management Committee. The Governor's Drought Task Force continues to share information and coordinate activities with the ACF drought committee. This committee is comprised of representatives from Alabama, Florida, Georgia, and the Corps of Engineers and is a continuing activity since 1985.

Coordination of activities and information sharing continues between the Alabama Governor's Drought Task Force and the Tennessee Valley Drought Task Force. The Tennessee Valley Drought Task Force consists of representatives from the Tennessee Valley Authority, the states of Alabama, Georgia, Kentucky, Mississippi, North Carolina, Tennessee, Virginia, the U. S. Geological Survey and the U.S. Army Corps of Engineers. This Task Force was established this year by the Tennessee Valley Authority..

As recommended at the initial task force meeting, subcommittees were formed to address specific areas of impact. The three subcommittees are: surface water, groundwater, and agriculture/forestry. The subcommittees are made up of task force members and other state and federal agencies who have expertise in the specified subject area.

June 23, 1988, ADECA and ADO representatives attended and participated in the National Governor's Association Committee on Agriculture and Rural Development. Work sessions were held on what the states and the federal government could do administratively and legislatively to ease the drought situation. Policy proposals resulting from the meetings were forwarded to the National Governor's Association Executive Committee for further consideration.

TASK FORCE MEETING - JULY 22, 1988

The second Governor's Drought Task Force meeting was held on July 22, 1988. Reports from the Governor's Drought Task Force subcommittees were presented. The task force discussed the need for the state to move into long-term water planning and coordination for Alabama. The consensus of the task force was that the state needs to develop a water resource planning process for Alabama.

ADECA is presently implementing a county water facilities planning project. This project is designed to develop an inventory of all water systems within a particular county, identify existing problems, and to establish priorities on a countywide basis for further development. A primary purpose of this project is to identify pockets of low and moderate income individuals not currently receiving water from an organized system. In addition, this project will assist counties in identifying and preparing alternate water supplies, such as neighboring water systems.

As a result of discussions at the July 22nd meeting, the Governor's Drought Task Force is sponsoring a conference on irrigation to be held on November 17, 1988. Cosponsors of the conference are ADECA, Alabama Farmers Federation, Alabama Cooperative Extension Service, Soil Conservation Service, Alabama Department of Agriculture and Industries and Auburn University. The purpose of this conference is to broaden the general level of understanding among farmers and the members of the agricultural community regarding the feasibility and economics of irrigation in Alabama.

Currently, ADECA staff is communicating with other southeastern and eastern states in an effort to research existing state water resource planning programs, policies and procedures as they exist and operate within those states. This information should be beneficial in determining the appropriate water resource planning process for Alabama.

CURRENT CONDITIONS

As of September, moderate to heavy rainfall has alleviated several drought conditions for the present in portions of Alabama (central and southern). The widespread rainfall brought by Hurricane Gilbert has raised the levels of several storage reservoirs in central Alabama. Lakes Harris and Martin reached full pool. Lakes Lewis, Smith and West Point have risen by 2.4 and 2.8 feet respectively. Levels in the Tennessee Valley storage reservoirs and Weiss Lake, however, declined over the same two weeks. Geological Survey of Alabama and U.S. Geological Survey are reporting that the hydrological drought is still evident throughout the state. Year ending stream flows and ground water supplies indicate deficits remain in many areas of the state. Figure 1 provides a rainfall summary for representative areas throughout the state. As indicated in the Departure From Normal (DFN) Column, many areas of the state remain in a deficit or below normal rainfall condition since January 1, 1988.

In summary, recent rainfall has provided relief to the agricultural drought. Although the received rainfall has done little to mitigate the hydrological drought which has taxed the state over the past few years. As indicated in this report, the reduced rainfall has significantly affected surface water and

groundwater supplies in areas throughout the state. Through the Governor's Drought Task Force meetings and activities has surfaced the impacts felt by all water users. In addition, Task Force meetings indicate a need for more efficient water resource management throughout the state.

CONTINUING ACTIVITIES

- Research other state policies
- Develop implementation procedures for "Water Resource Management Commission"
- Continue to monitor drought conditions
- serve as intermediary on problem solving

Figure 1

Alabama Rainfall Deficit Summary Through October 12, 1988

Location	Rainfall Total Since Jan. 1	DFN % Since Jan. 1	DFN in Inches Since Jan. 1
Anniston	36.44	-17	- 7.27
Auburn (AG)	43.94	- 4	- 1.91
Belle Mina	26.82	-36	-14.90
Birmingham Airport	33.27	-25	-11.36
Birmingham City	30.52	-28	-11.95
Brewton	57.36	12	+ 6.07
Camden	38.48	-18	- 8.26
Centreville	35.61	-20	- 9.04
Demopolis	41.22	- 4	- 1.86
Dothan	42.00	- 7	- 3.39
Fairhope	62.60	16	+ 8.67
Gadsden	40.98	- 6	- 2.65
Geneva	52.07	7	+ 3.62
Headland	46.11	2	+ .72
Huntsville	33.16	-24	-10.37
Marion Junction	42.07	- 2	- .94
Mobile	58.04	7	+ 3.58
Montgomery	50.07	24	+ 9.65
Muscle Shoals	28.22	-31	-12.86
Pinson	36.04	-20	- 8.79
Sand Mountain	35.68	-18	- 8.02
Selma	36.10	-17	- 7.45
Thorsby	42.94	- 9	- 4.12
Tuscaloosa	38.72	- 9	- 3.82
Winfield	35.68	-20	- 9.01

DFN is Departure From Normal.

The State of Illinois Response to the 1988 Drought

by

The Illinois Water Plan Task Force
Drought Response Task Force

BACKGROUND

The Water Plan Task Force for Illinois was appointed by Governor James R. Thompson in 1980 to guide policy decisions regarding the adequacy of programs to deal with increasing numbers of water issues. The Task Force is comprised of members from the Office of the Governor, Illinois Water Resources Center, Departments of Transportation, Agriculture, Conservation, Commerce and Community Affairs, Mines and Minerals, Public Health, and Energy and Natural Resources. In addition, the Illinois Environmental Protection Agency, Emergency Services and Disaster Agency, Bureau of the Budget, and the Capital Development Board are also represented.

The initial focus of the Task Force is on either significant water issues not being sufficiently addressed by current programs or emerging issues which can be anticipated to lead to future problems or conflicts. In consideration of public and advisory group views and its own maturing judgment, the Task Force agreed upon ten issues upon which to proceed. These ten issues are:

1. Erosion and Sediment Control
2. Integration of Water Quality and Quantity Management
3. Water Conservation
4. Flood Damage Mitigation
5. Competition for Water
6. Aquatic and Riparian Habitat
7. Water-Based Recreation
8. Atmospheric Changes and Management
9. Drought Contingency Planning
10. Illinois Water Use Law

The Water Plan Task Force issued a special report dealing with the Drought Contingency Planning issue. It was recognized that several on-going programs useful to the State's drought contingency programming activities were already in place within several agencies. This recognition led to the formation of a Drought Response Task Force (DRTF).

DROUGHT RESPONSE TASK FORCE

The DRTF is convened by the Governor or by the Director of the Water Resources Division of the Illinois Department of Transportation. The DRTF is co-chaired by the Director of the Water Resources Division and the Head of the Public Water Supply Section of the Illinois Environmental Protection Agency. Representatives from the following State agencies are included on the DRTF:

Illinois Department of Transportation (Water Resources Division, Co-Chair). (DOT/DWR)
Illinois Environmental Protection Agency (Public Water Supply Division, Co-Chair). (EPA/PWSD)
Illinois Department of Commerce and Community Affairs. (DCCA)
Illinois Department of Agriculture (Natural Resources Division). (DOA/DNR)
Illinois Emergency Services and Disaster Agency. (ESDA)
Illinois Department of Energy and Natural Resources (Water Survey Division). (DENR/SWS)
Illinois Office of the Governor. (OG)

It was recognized that the Illinois Department of Conservation (Resource Management Division) (DOC/RMD) should also be included among the member agencies, and was soon added.

Each Task Force agency has technical expertise and capabilities in specific areas of drought management. Their capabilities include in-depth knowledge of statewide rainfall distribution on a daily basis, evaluation of alternate water supply sources for both emergency and long-range uses, installation of emergency pumping and piping equipment, water sanitation and quality considerations, graduated water conservation practices, aquatic habitat impact assessment, and methods of financing alternate water supplies.

The DENR/SWS issues a monthly summary of water and weather conditions for the entire state to each of the DRTF agencies throughout the year and this information is used to detect the onset of a drought. This summary includes lake and stream stages, groundwater levels, soil moisture, and pertinent weather variables such as precipitation and temperature.

The Co-Chairs assess the water and weather information and convene the DRTF when conditions show continual declines in the available water resources. Each of the agencies also maintain staff in the field and the awareness of real or potential impacts from precipitation deficiencies is frequently brought to the attention of the DRTF through staff contact with the public and local units of government.

When convened, the DRTF sets a schedule for regular weekly briefing meetings usually by conference telephone arrangements, but also, when necessary, face-to-face to resolve particular issues. The Water Plan Task Force was sensitized to the evolving 1988 drought as early as May, and the DRTF was convened and began weekly briefings in June. At the time of this writing the DRTF continues to discuss the water situation in Illinois and will remain active until such time that recovery of the resource is obvious.

PERTINENT ILLINOIS LAW

The DRTF does not possess any regulatory power unto itself, but those agencies that have statutory authority also carry that responsibility to the Task Force deliberations. The implementation of

agency power will be discussed where appropriate in the following pages.

SEVERITY OF THE 1988 ILLINOIS DROUGHT

The summer of 1987 was generally 40-50% drier than average in Illinois, except for August when rainfall was about 150% of the 1951-1980 average. A dry fall permitted an early and efficient harvest, but November and December were very wet in the state. January and February of 1988 reported near average precipitation, but with a change to less frequent and less magnitude precipitation was experienced from mid-February through September. This change was not then perceived to be a problem by many until mid- to late-May. By this time the precipitation shortfall was clear, and the potential impacts on agriculture through the accumulation of soil moisture, surface and ground water deficits became a serious concern.

From January through March of 1988 statewide precipitation was within 9% of average, although there were relatively long periods without precipitation, especially after mid-February. April, however, marked the first month when precipitation was below average for the entire state. Indeed, west-central Illinois received less than one inch, whereas 4 inches is average. With time, west-central Illinois emerged as that portion of the state with the greatest precipitation deficit. The statewide deficit accumulated at a greater rate during the next three months with less than 50% of average precipitation observed in each of the months.

A common measure of drought severity is the recurrence frequency. For the April through June total precipitation, the recurrence frequency is about 8 years, and this value is not particularly unusual. However, the recurrence frequencies are based on 3-month totals from all months of the year. The occurrence of such severe dryness in these three months of spring places 1988 in a somewhat more unique category.

About two-thirds of the state received less than 50% of average rainfall during July, August, and September. Only the extreme northeast, and northwest, and a narrow band in south-central Illinois recorded summer precipitation of as much as 60% to 70% of average. The remnants of Hurricane Gilbert provided some short-lived relief with one to two inches of rain in eastern and southern Illinois.

Using the departure from average as a severity indicator for comparison with previous Illinois droughts, the July-August period in 1988 ranks third behind 1983 and 1936. However, a comparison between these three ranking droughts and all other July-August droughts in the long climatic record of droughts in the state shows them to be outliers. In simple terms, the 1988 drought is an extreme event.

The water year extending from October 1987 through September 1988 has ended with accumulated precipitation deficits of between less than two inches in parts of southern Illinois to greater than 14 inches in western counties. The deficit continues to build into the water year beginning October 1, 1988 and unless a change is ex-

perienced soon the water resource problems and conflicts will multiply by spring 1989.

1988 TASK FORCE ACTIVITIES

The DOT/DWR establishes the agenda for the weekly conference call which usually begins with a discussion of past rainfall, the accumulating deficit, and the outlook for precipitation in the short- and long-term. This is followed by a briefing by the EPA/PWSD on public water supplies that are in danger, and the status of crops and livestock by the DOA/DNR. The ESDA and DCCA describe their emergency equipment and funding application requests. The DOC/RMD reports on the status of state-owned lakes and any observed impacts on wildlife. The OG representative provides guidance regarding policy issues and maintains an awareness of the entire evolving drought picture to brief the Governor and seek Executive power when deemed necessary.

All participating agencies with statutory authority reacted to accelerate requests through their respective systems regarding permits, variances, and other forms of assistance.

DOT/DWR 1988 Activities

In addition to serving the DRTF as the Co-Chairman and as the focal point for the information from all participating agencies, the DOT/DWR acts directly to resolve emerging water use conflicts.

For example, the DOT/DWR, with support from other agencies, met with irrigators to seek voluntary restriction on their water use where such high capacity wells were presumed to impact domestic wells in the area. The meeting was very successful and achieved nearly 100% cooperation among the irrigation well operators.

The DOT/DWR was also involved in developing the State's position regarding the diversion of additional Lake Michigan water through the Illinois River system to assist commercial barge traffic below St. Louis.

A public utility requested permission from DOT/DWR to alter the dike structure around a cooling water lake for the purpose of importing additional water from a nearby abandoned strip-mine lake to make up losses due to excessive evaporation and the inability to withdraw adequate water from the primary nearby river source.

EPA/PWSD 1988 Activities

The Public Water Supply Division maintains liaison with plant operators throughout the state and retains records of available resource and consumption. They also work directly with several communities to assist in resolving water quality issues as new sources are sought. This information is communicated during the weekly meetings and other agencies then respond as appropriate.

Based on historical supply performance, the Agency carefully and frequently monitors 20 public water supplies. Of these 20, 16 have repeatedly experienced water shortages in less severe droughts than 1988.

Some emergency permitting has been granted to use water supplies not previously considered for public use. An example is that of a

small community requesting to utilize water from an interstate highway borrow pit by direct connection to the existing treatment and distribution system.

The EPA assisted the U.S. Army Corps of Engineers to insure the water quality standards were met in the development of an abandoned well and supply system for a small community in eastern Illinois. They also worked closely with suppliers reaching into new surface waters and various quarries to insure maintenance of high quality water for the public.

DCCA 1988 Activities

Pamphlets on water conservation were prepared and more than 500 were distributed to municipalities for local copying and distribution. Additional drought-related material is in preparation and will be printed and distributed by the DCCA. In other words, the DCCA coordinates communications efforts between the Task Force and local units of government.

The Community Development Assistance Program funds are administered by DCCA for the improvement of public facilities. A single small community applied for funds to redrill wells and reset pumps in an area of high irrigation pumpage. It is somewhat surprising that more applications for improvement of water systems were not requested during this very severe drought.

A mass mailing is in preparation to community leaders offering assistance in the form of future workshops on local drought management by Task Force members and the provision of model ordinances to provide authority to local government during times of water emergencies.

DOA/DNR 1988 Activities

The DOA/DNR publishes a weekly crop report that includes the condition of crops during the growing season and the status of soil moisture. This report provides a near real-time assessment throughout the growing season of the impact of rainfall on agriculture in Illinois.

Livestock growers were a major concern of the DRTF and a number of alternatives were considered to insure water for their operations. Three reservoirs operated by the U.S. Army Corps of Engineers became available for water hauling upon application. The ESDA provided a pump and personnel at the allocation site, but fortunately the water emergency was not so severe for livestock and only a single permit was issued. In other areas of the state not so close to surface lakes, the EPA/PWSD compiled a list of locations where treatment plant effluent was of sufficiently high quality that it could be used for livestock watering. Again, not only was their some concern over the use of the water by the growers, but other alternatives and ordinary on-farm supplies were adequate during the year.

The DOA/DNR established a "Hay Hotline" to serve as a means to bring together sellers and buyers. The sellers almost outnumbered the buyers by 2 to 1 with 489 and 234, respectively. The Hotline received numerous additional calls seeking information as opposed to regarding buying or selling. How many sales were actually made is

not known, but the service provided was received very well by the farm community.

ESDA 1988 Activities

A minimal length of piping and at least two pumps are maintained by the ESDA for distribution within Illinois where needed to tap into alternate water supplies during emergencies. Only recently have these been strained by requests, but fortunately their help in solving a short-term problem in one area has released them for use in other communities. The drought of 1988 has shown that these facilities should be increased in anticipation of the next water emergency.

The ESDA worked with the Illinois National Guard to provide water "buffalos" to those communities without a nearby water source. These are still in place as long-term solutions are being considered by the affected towns.

Emergency funds are available to assist recovery from natural disasters although no applications for such funds were received in spite of the spotty, but extreme, water shortages around the state.

DENR/SWS 1988 Activities

In addition to its role in providing weather and resource depletion data to the member agencies, the DENR/SWS was also responsible for evaluating alleged interference between high capacity wells and nearby wells. This responsibility was statutorily given as part of the Illinois Water Use Act of 1983 as amended in 1987. This law permits one well owner to file a complaint against another with the county Soil and Water Conservation District (SWCD). The complaint, including a description of the nature of the perceived impact, is then forwarded to the DENR/SWS for evaluation in the field and a written report is prepared for the SWCD. If it is found that a well that is constructed in accord with state standards has been impacted by a high capacity well, the DOA/DNR then has the authority to decrease pumpage from the offending well.

Thus far, nearly 160 complaints have been filed and more than 50% have been evaluated in the field. Of the 78 investigations no wells can be confirmed as being impacted by nearby irrigation practices, but primarily because the wells do not conform to the standards established by the state for domestic wells.

The surface and ground water engineers in the DENR/SWS were strained to meet the enormous number of requests for assistance. These requests ranged from giving advice on new potential sources to evaluation of quantity from newly developed resources. The data base of nearly 100 years of the DENR/SWS was invaluable for responding to the needs of individuals and local government units.

DOC/RMD 1988 Activities

The DOC/RMD provides indicators of the drought severity by continuously monitoring the terrestrial and aquatic natural systems throughout the state. Many migratory birds departed typical habitats in search of suitable feeding areas. Some have entirely left the state while others are concentrated in smaller, suitable areas

subjecting them to predators. The prairie grass seed crop has been a total loss in 1988 posing future habitat problems for some terrestrial species.

Numerous fish kills have been reported especially in small ponds due to extremely hot water temperatures, lowered water levels, and diebacks of algal blooms. The severe impact on crops has secondarily caused some small pond fish kills due to pesticide spraying to control spider mites on soybeans. On some major lakes and streams decreased concentration of dissolved oxygen has been directly responsible for fish kills.

In addition to monitoring the drought impacts on these natural resources, the DOC/RMD maintains a number of lakes for recreation in Illinois and those that represent sufficient storage as water supplies are made available, if necessary, in stressed areas. Thus far, there has not been a need to draw upon these lakes for water supply, and as the drought continues the number of lakes available diminishes in deference to sustaining fish populations for the future.

OG 1988 Activities

The Office of the Governor serves to provide the Governor with the current status of the drought and advice as to the proper time to intervene in water conflict issues within the powers vested in that office.

STRENGTHS AND WEAKNESSES OF THE ILLINOIS DROUGHT TASK FORCE

The DRTF serves the people of Illinois well by acting as the focal point for dealing with water shortage problems at all levels of need. The weekly meeting of the Task Force composed of all agencies within Illinois state government with responsibilities for water allows information, funding and permitting requests to be expedited during times of water resource stress.

The various agencies represented on the DRTF have, by their very nature and responsibilities, staff offices and personnel scattered throughout the length and breadth of the state. This is an important element in the early detection of problems and allows the Task Force time to take appropriate action to ameliorate the problem.

The news media are used extensively by the DRTF to increase awareness by the people of the state's efforts to assist them in securing water for their health and safety. The success is borne out as the drought extends in time by the increased information flow to the Task Force from municipalities and individuals.

The single most important weakness of the DRTF is the lack of statutory authority to take any action to more directly alleviate water shortage problems. The Task Force serves in an advisory role only and cannot mandate action by either individuals or municipalities. The previously mentioned Water Use Act is not an authority given to the Task Force , but is vested in the DOA and cooperating agencies. Some frustration was felt by Task Force members that some authority was not available when water resource problems were known and information was available to assist local units of government, and yet communities failed to act on the information and advice

given by the Task Force.

SUMMARY AND DISCUSSION

The primary accomplishment of the DRTF has been the relative success in advising local government units of their water problems and offering them possible solutions. The solutions are normally all within the ability of local governments to resolve. With each returning drought, the number of troubled communities decreases because they have previously adopted a long-range solution. At the same time, each successive drought adds new communities to the list of problems owing to either aging of existing facilities, impoundments, and so forth, or due to local development in an already stressed resource area.

The DRTF works by the method of persuasion and has been very successful in this most serious drought period. Most communities recognize their growing water resource problem and are willing to listen to advice. Surprisingly, no individual or local unit of government expected the state to solve their problem.

The drought of 1988 is not over and it is too early to provide an in-depth assessment of improvements needed to enhance the ability of Illinois to respond to drought emergencies. However, there are one or two things that are readily apparent and worthy of discussion.

First, there is the question of the degree of authority that state government can or should possess to mandate to individuals and local units of government measures regarding water resources and their use. Second, differing levels of water shortage may make it desirable to define different levels of response from state government.

Illinois is a state with a rich water resource, both surface water impoundments and productive ground water aquifers. Past tradition is that the only water problem most frequently encountered is that of too much water during periods of flooding. The issue of water use conflict is of recent origin and has not been addressed satisfactorily in Illinois law. The previously described Water Use Act (as amended) only applies to four of the 102 counties in the state. Should this law be re-examined, strengthened, and adopted for the entire state? Nearly 50% of the water resource use is derived from Lake Michigan diversion and feeds the heavily populated northeastern counties of Illinois. However, the remaining 50% is largely ground water and in the agricultural areas where competition for the resource is experienced most frequently. These issues have been highlighted by the 1988 drought and will become key issues for the assessment of the DRTF by the Water Plan Task Force in the future. These deliberations will undoubtedly point to the need for new or amended legislation on the state's role and responsibility in dealing with future water resource problems.

The second problem is related to levels of responsibility for the available water resource extending from individuals to local units of government. When is a drought a drought? In the absence of accurate forecasts of water deficits, most droughts are initially "felt" as opposed to quantitatively measured. At what level of impact should the state activate a warning system that water resources are in jeopardy? A legitimate concern is that the state can

overreact to a perceived problem only to have the problem disappear with the next catch of precipitation. This definition of level of involvement is also to be considered by the DRTF and the Water Plan Task Force.

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THE OPERATION OF THE SOUTH CAROLINA DROUGHT PLAN DURING THE 1988 DROUGHT

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South Carolina is one of the few states in the union with a comprehensive drought response plan. A significant occurrence in the history of the state was the passage of the Drought Response Act of 1985 and supporting regulations in 1986. Together, these form the core of the South Carolina Drought Response Plan. This plan establishes procedures for monitoring and responding to drought. It also divides the state into six drought management districts and gives procedures for selecting personnel for managing these districts. It also places certain requirements on all public water suppliers, provided for systemic drought monitoring, and sets up the mechanism for an orderly response in the event drought occurred. The South Carolina Water Resources Commission is the lead agency in the implementation and operation of these drought response procedures.

The operation of the drought plan during 1988 showed an orderly transition from a dry winter to a period of considerable stress during the summer months, followed by some relief during late summer. Monitoring of water and soil moisture conditions during the fall and early winter of 1987 indicated a need for additional rainfall. The U.S. Army Corps of Engineers, Savannah, Georgia District owns and operates 3 major reservoirs on the Savannah River above Augusta, Georgia. During a meeting with the South Carolina Water Resources Commission in early November, Corps personnel indicated concern at the lower than normal elevations of these reservoirs along the Savannah River and proposed reductions in operations in order to allow more recovery from these low levels. October 1987 was the driest October on record in the drainage area of the reservoirs.

The South Carolina State Climatology Office of the SCWRC under the SC Drought Response Act does the actual day to day drought monitoring. This Office noted a continued worsening of soil moisture conditions during the late winter and early spring. On April 11th an incipient drought alert was issued for the six drought management areas. This declaration by terms of the Drought Response Act required an increase in monitoring as well as an increased awareness of drought response procedures.

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The Drought Response Act uses the Palmer Drought Index and other indicators (streamflow, reservoir levels, etc.) to aid in the declaration of drought phases. It also allows the Commission to declare drought phases for small areas, to prevent overly broad response. Three counties, Anderson, Oconee, and Pickens, in northwestern South Carolina were declared to be in a moderate drought in 1988. This was declared on June 13, and ended on September 12. As of the time of this writing(October 14, 1988), the entire Northwest Drought Management Area (see figure 1) was still experiencing an incipient drought phase.

Several cities throughout the Northwest, West Central, and North Central portions of the state during the summer asked their citizens to voluntarily monitor their water use. As of this writing, only one city still had voluntary water use restrictions in place.

Although the drought of 1988 will be remembered mainly for its effects in the midwest and high plains, in the Southeast it will be remembered as one more dry year. Unfortunately, the 1988 drought came at a time when the state was in a prolonged period of drier and warmer conditions. Walhalla, in Oconee County, has lost one year of normal precipitation over the past 8 years. Other sites are similar in their cumulative precipitation loss.

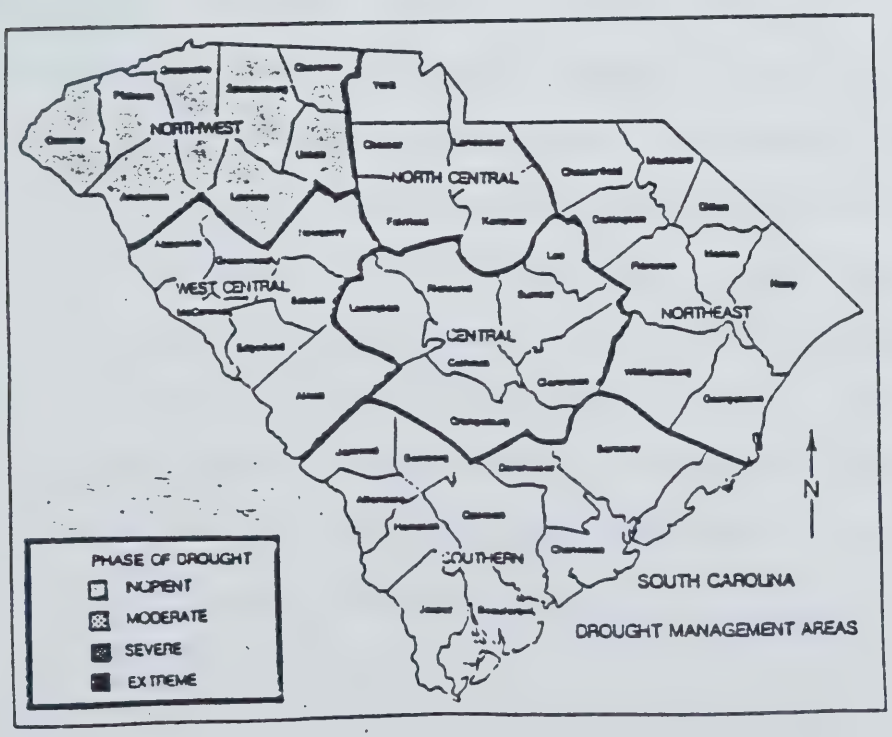
The operation of the South Carolina drought response plan during 1988 proved useful to both state and local officials as well as to all citizens. The weekly monitoring of drought conditions provided timely information on the drought status. When soil moisture deficiencies in several counties in the Northwest Drought Management Area reached the criteria established for a moderate drought alert, the Local Drought Committee convened in accordance with provisions of the Act. This action was well received and certainly gave the perception that local and state government were in full control of the emergency. An added benefit was the action by cities, towns and other public water suppliers. The Act requires public water suppliers to have drought ordinances in place for use during drought and periods of water shortage. These ordinances made it possible for water shortages to be handled at a local level with minimum confusion.

The most obvious weakness to the SC Drought Response Act that surfaced was the rather time-consuming method of selecting replacements to the Local Drought Committee's. However, the overall evaluation of the Act to date, is a strong vote of approval by all concerned.

Fig. 1

DROUGHT DECLARATION DATES IN 1988 AND LEVELS OF DROUGHT

DROUGHT MANAGEMENT AREA	INCIPIENT			MODERATE		
AREA	BEG.	END	COUNTIES	BEG	END	COUNTIES
NORTHWEST	4/11		ALL	6/13	9/12	ANDERSON OCONEE PICKENS
NORTH CENTRAL	4/11 6/20	4/25 9/12	ALL ALL			
NORTHEAST	4/11	4/25	ALL			
WEST CENTRAL	4/11	9/12	ALL			
CENTRAL	4/11 8/22	4/25 9/12	ALL ALL			
SOUTHERN	4/11 8/22	4/25 9/12	ALL ALL			



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DROUGHT MANAGEMENT PLANNING

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During the severe 1986 drought, it became evident that a specific plan was needed in North Carolina for responding to drought conditions and to facilitate better coordination among State agencies.

Many water systems in North Carolina are not prepared for droughts or other water-related emergencies. Some systems are not fully aware of the reliability or limitations of their existing sources of supply during critical periods. Few systems have developed drought, conservation, or management plans.

The Division of Water Resources (DWR) of the N.C. Department of Natural Resources and Community Development assists local governments in ensuring that sufficient quantities of water are available to meet present and future demand, both in normal times and during drought periods. Their personnel work closely with the Public Water Supply Branch (PWSB) of the N.C. Department of Human Resources, which is responsible for ensuring that public and private water systems meet public health standards.

A primary goal of DWR's long-range water supply planning function is to reduce the impact of droughts by encouraging and facilitating local and regional water supply planning. The success of these long-range preventative measures can be measured to some degree by the reduction or absence of serious water quantity problems during droughts.

We believe that it is very important for every water system to have a drought management plan. When we talk about a "drought management plan," we should be talking about an entire package of how a system will cope with a drought. An effective ordinance should be a part of this plan, but there is more to a plan than just an ordinance. In effect, the whole community needs to be mobilized behind the plan and understand what is involved. Therefore, system managers need an education program, organized working groups, and support of the press, all incorporated in their plan. Each system has individual differences; that is, each system has different problems. Therefore, the plan that system managers develop and the ordinance that they develop needs to be tailored specifically for their specific community. Although many features may be similar, the plan that Charlotte has won't work for Asheville, and the plan Asheville has won't work for Bryson City.

The first step in developing a plan is to gather all basic information and data: records of water use, records of unaccounted-for losses, and records of how the system behaved during the last drought. This includes lake level records, records of streamflow, groundwater levels, and well pump performance. Guidance on assembling this information is available from the Division of Water Resources.

The next step is individual assessment of the system, the most important being the evaluation of the water source. What can be expected from a water source during times of drought? Any records available may be of some value. The bottom line of this evaluation is to determine the yield available from the

source or sources during a severe drought. The DWR can provide assistance in helping to determine this figure. There are also a number of good consulting firms who can help.

After it is determined what the yield would be during a drought, the second most important item is to consider reducing the amount of water that is used during dry periods. This usually takes a two-fold approach: 1) The reduction of water loss in the distribution system, and 2) reduction of water used by system customers. Generally, the more severe the conditions, the more severe the emphasis has to be on reducing total water requirements for the system. Prior to the drought, every system should consider conducting a comprehensive water audit for their entire operation. This will not only reduce water losses and improve finances, but will increase knowledge of the system and improve system efficiency and public relations.

There are many ways that water can be lost in the distribution system. Some of these losses are only "paper" losses, others are actual. Paper losses are through inoperable or inaccurate meters, ineffective accounting systems, and poor management. But the most important area to be dealt with in the short-range of an ongoing drought is the actual losses in the system. There is some help available from various agencies. DWR has a specific sub-program that deals with water losses and leak detection.

The other area of emphasis deals with the reduction of use of water by customers. Not only residential water use, but industrial, commercial, and institutional water use are areas that should be addressed. History has shown that significant

reductions in water use can be achieved. Commercial operations and institutions, such as schools and hospitals, should all be encouraged to study ways and means to reduce overall water use. DWR has material available that can be used to help reduce residential water use. Some of this material consists of mailout items for the homeowner. Also, there are some physical items that can be incorporated into the plumbing system, such as flow reducers for showers, and dikes for water closets that will reduce water use. These can be used not only in individual residences, but in all types of operations.

Once there is a reasonable understanding of how the system behaves during a drought, a plan can be prepared that addresses the existing conditions of the raw water source and the expected future conditions of the raw water source. This information in turn would dictate the limit on the amount of water to be used by the system and the amount of reduction in water use required to achieve that limit. Therefore, a carefully prepared drought management plan would include a call for certain levels of reduced water use based on the condition of the raw water supply. As conditions become more severe, certain non-essential water uses, such as lawn watering and car washing, would cease. As the severity of the conditions increases, water reduction requirements would move from voluntary to mandatory. Mandatory would, of course, have associated penalties for water use.

We understand that preparing a drought management plan may be a difficult assignment for many managers. In order to help address this problem, DWR has prepared a self-help handbook

that communities can use in coping with a drought. This self-help handbook talks about organizing a local effort, dealing with the press, assessing the water system, reducing water uses and losses, and developing conservation ordinances. In addition, DWR has several types of sample ordinances for large and small systems for groundwater and surface water sources, etc. It should be remembered that each system has to tailor its own plan or ordinance to fit its individual situation. A sample ordinance without proper modification and adjustment for what the individual system needs will not work.

Assistance is available from the State on an individual basis at this time. As the drought intensifies and more systems begin to have problems, the resources that agencies can devote to any one water system will be very limited. The system manager should seek help early. Services provided by DWR to help local governments and water systems prepare to meet their water needs during future droughts include:

A. Notification to water systems that could develop critical water supply shortages during drought.

B. Identification of potential emergency water supply sources. DWR will also coordinate with the PWSB to assure the adequate quality of emergency supplies.

C. Publication of a Status of Water Supply or Drought Advisory Newsletter and other educational materials to inform citizens and local officials of water resources conditions and advisable conservation measures.

D. Assist local governments without a conservation ordinance in setting and achieving water reduction goals for residential, commercial, and industrial water users.

E. Assist in the preparation of drought management plans, evaluation of existing drought management plans; preparation of conservation ordinances, and updating existing water conservation ordinances.

F. Assist local governments and water systems in establishing water pricing structures which will encourage water conservation by residential, commercial, and industrial water users.

G. Survey water supply reservoirs and wells to determine the expected yield of raw water sources during critical droughts and determine the chance of water supply shortages based on expected use.

H. Work with water system personnel to evaluate the operation of the system and develop improvements in efficiency in the water supply and distribution system.

I. Provide assistance, training, and equipment to survey and identify location of underground leaks and unaccounted-for water use/loss within the distribution system.

J. Assistance in analyzing costs and benefits to determine whether the expense of repairing or replacing the water system infrastructure will be justified by the water savings and long-term financial savings.

As mentioned before, DWR also has materials for reducing water use by customers, and will soon have a short tape suitable for running on local TV stations, which talks about residential water conservation.

DWR has developed an interagency coordination document that deals with more efficient use of State resources in dealing with drought. DWR serves as a point of contact for water systems which experience drought-related emergencies, providing both technical expertise and information regarding other sources of assistance, including Federal and other State agencies. Features of this document provide for DWR to be responsible for the following:

A. Notification to the Division of Emergency Management and the PWSB of water supply systems that have a high risk of experiencing severe water shortage problems.

B. Provide up-to-date information on the severity of drought wetness conditions for selected areas across the State. This information is obtained by regularly monitoring the rainfall, streamflows, reservoir levels, and soil moisture at key locations throughout the State. DWR cooperates with State and Federal agencies and local governments to obtain these data.

C. Assist in conducting a risk analysis of reservoir levels and changes in operation schedules of wells. This analysis can be used to establish stages or levels for a water conservation program as related to available water supply and reduce the likelihood of the development of a crisis situation.

D. In cooperation with PWSB, assist the local water system to ensure that an adequate supply of potable water is available when drought conditions exist that cause the quality of water obtained from existing sources to be in question.

E. In the event of an extreme water supply emergency due to drought or other causes, DWR will represent the Environmental Management Commission to ensure that drought-stricken communities enact water conservation measures necessary for them to qualify for emergency diversion of water, as outlined in G.S. 143-354a(3) see appendix).

DWR strategy for the initial phase of the 1988 drought in western North Carolina dealt with identifying those systems that we thought were going to have problems during the coming drought, making field visits to those systems to further evaluate their situation, and offering assistance and providing information. We believe that awareness of the situation and awareness of the steps to be taken to deal with it was the key to dealing with the drought of 1988.